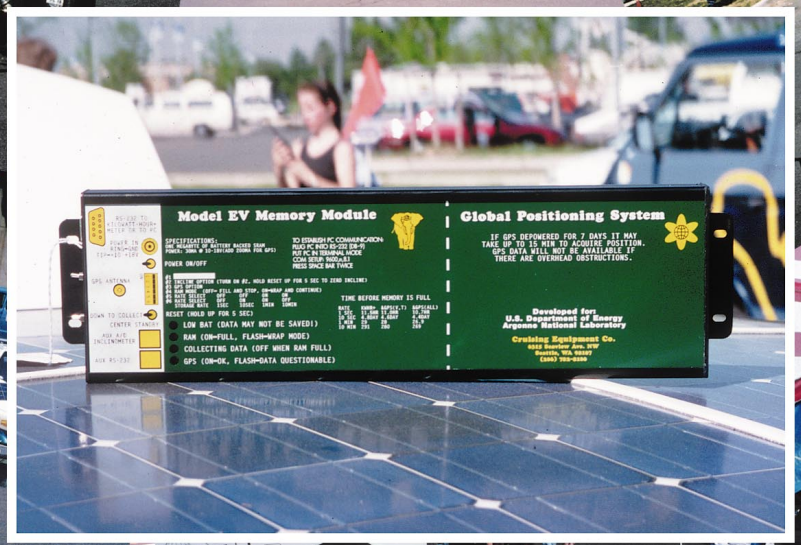


Cruising Equipment Company
6315 Seaview Avenue N.W. Seattle, WA 98107 U.S.A.
(206) 782-8100 Fax (206) 782-4336

Memo

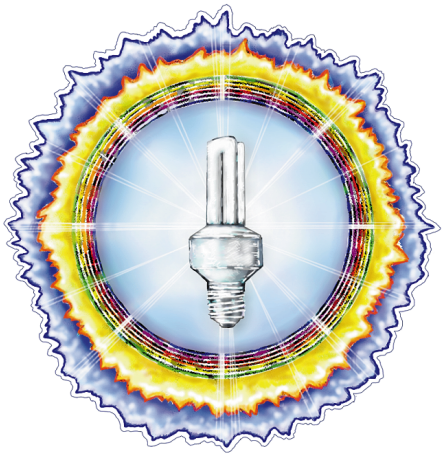
To: Advertising Dept.
From: Rick Proctor

Please come up with an eye catching ad which shows some of the vehicles we instrumented this year at the American Tour de Sol and the HEV Challenge. Have it mention that our Kilowatt-Hours+ meter, with the new Memory Module, and GPS were chosen by Argonne Labs/DOE because they log vehicle speed, Amp-Hour and Kilowatt-Hour consumption once a second. Try to find some way to mention that installation is a snap because there are no sensors other than the current shunt and the GPS antenna. We should also mention the inclinometer option which plugs into the memory module. Someone in Marketing mentioned one of the Big Three is testing the setup now, too. Get it in the leading publications like Home Power right away -- people gotta hear about this.

ALSO mention people can write for the new catalog

Thanks!

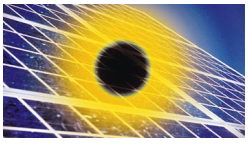
Rick

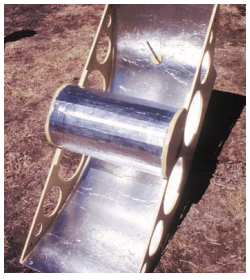


HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #43 October / November 1994





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Access and Info

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Recyclable Paper

Photo by Robert Hale of Hana Maui, Hawaii. Robert goes home to RE-powered lights at night.

As Regular as Sunshine

Many thanks to all of you who took the time to fill out and return the energy survey form in *Home Power* #42. The summary of your information and opinions is on page 16 of this issue.

If you haven't yet participated in the energy survey, then please take the time to complete the survey and return it to us. The survey form can be found on page 16 of *Home Power* #42. A new age of energy is dawning. Your opinions and experiences can influence our future. Take time to let your voice be heard.

the Home Power Crew

People

Bob Battagin
Clare Bell
Jay Campbell
Sam Coleman
Renaldo Cortez
Charlie Cowden
Felicia Cowden
John Dabritz
Michael Hackleman
Robert Hale
Jim Healy
Kathleen Jarschke-Schultze
Todd King
Stan Krute
Dan Lepinski
Don Loweburg
Harry Martin
Bart Orlando
Dann Parks
Karen Perez
Richard Perez
Shari Prange
Walt Pyle
Mick Sagrillo
Byron Stafford
Bob-O Schultze
Michael Welch
Nicole Whittick
John Wiles

" Think about it…"

"Sad soul, take comfort, nor forget that sunrise never failed us yet."

Celia Layton Thaxter
1835-1894

Solar Depot

four color
camera ready

full page

this is page five

Above and below: Transportation in the Amazon basin is by water or foot. Yacumama Lodge is 90 miles upriver (or five hours) from the nearest large town.

Luz del Sol

Charlie & Felicia Cowden

This summer we helped install a photovoltaic system at Yacumama Lodge, a tropical eco-tourism resort in Peru. Such remote locations with year-round sun make excellent sites for solar.

Self-sufficiency is essential to this secluded camp, located deep in the Amazon headwaters. Boats provide the means of supply and the only source of expensive fuel for electric generators is ten hours away downstream. Solar power frees the jungle camp from this costly dependency. It also supports Yacumama's main purpose — preserving the rainforest.

For us, this project provided an enjoyable experience as well as an opportunity to learn about the Amazon region. We gained insights into planning, purchasing and installing a remotely situated PV power system in a South American country. As we share our experience, we will highlight what worked well and what didn't.

Problem Solving

Lawrence Bishop, Yacumama's owner, is a neighbor of ours in Kauai, Hawaii. A year ago he had purchased a large solar power kit for his unfinished camp from a catalog, but had not yet installed it.

He contacted us because we design, sell and install solar power systems. Lawrence had a contractor/partner, Norman Walters, who lived in Peru and was building the camp. When Norman received the original kit, he looked over the instructions and equipment, but the project was unfamiliar and thus too time-consuming. He sidelined it and focused instead on the larger task of completing Yacumama.

At the time we first spoke to Lawrence Bishop, the solar equipment had been sitting unused in Peru for over a year. He and Norman Walters were understandably discouraged with solar and wondered if it would work at all. We were familiar with the kit he had purchased and assured him that it wasn't a mistake; the equipment would work.

After quizzing Lawrence about his understanding of solar energy and what it could do, we analyzed the camp's needs in detail. We did an energy budget for Yacumama to see if what Norman already had was appropriate. If not, we could send down additional components and replacements.

Before throwing more money into solar, however, Lawrence wanted to get the existing equipment on-line. If it proved out, he'd finance an upgrade. The job was "hook up what we've got and if it works, add on." We agreed. Lawrence departed for South America, leaving the task in our hands.

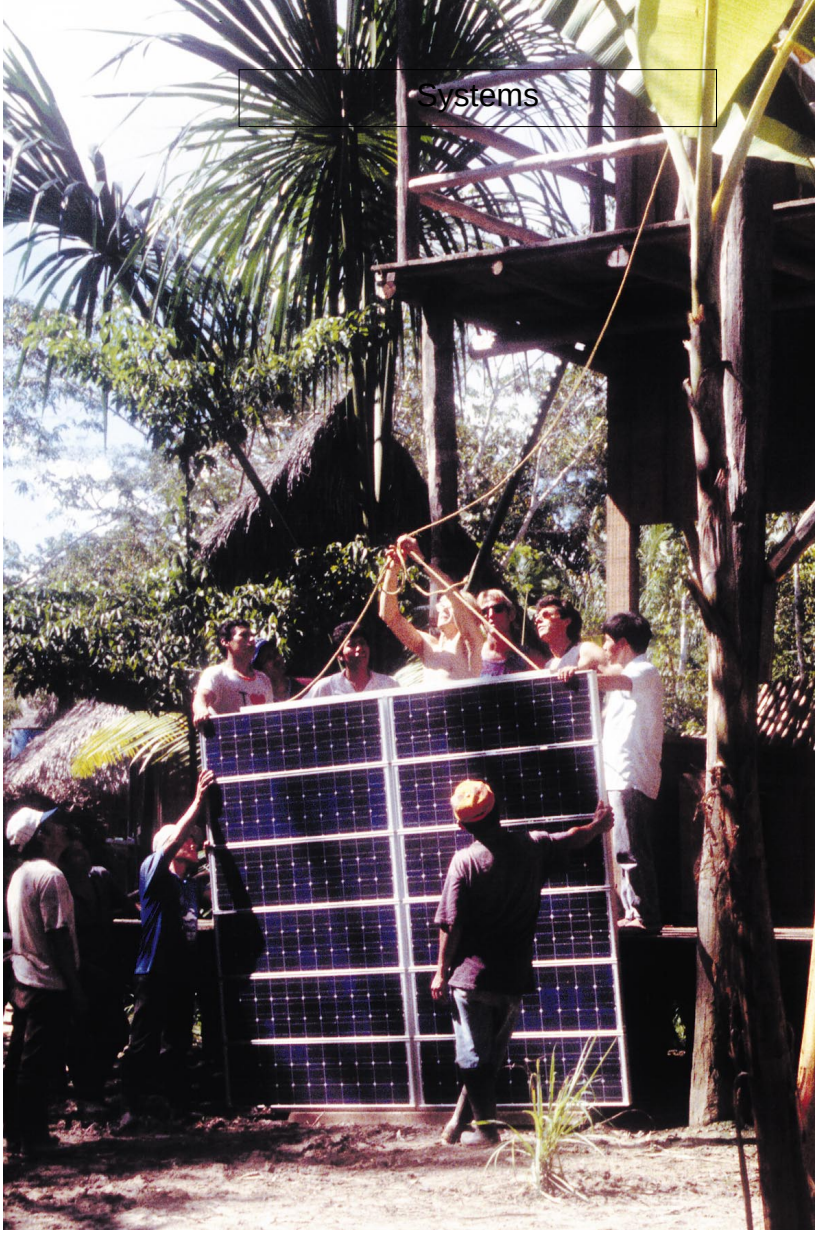
The distance to Iquitos, the nearest outpost, would eliminate any casual trips to the hardware store. We would have to do a site evaluation by faxing instructions to Norman when he left the jungle for Iquitos on the weekend. We designed the Yacumama system to include the existing components and whatever was available in the Amazon region, as well as what we could ship down.

Norman had already built a forty-foot tower for the existing solar modules. The Yacumama Lodge roof faced north and had a a fairly flat pitch. This was ideal for a major PV installation in the southern hemisphere. The support equipment for the panels would be on the second floor.

Plunging into the project, we drew sketches, made measurements, exchanged faxes with Norman, calculated voltage drops and developed lists of materials. Weeks went by. In line with Yacumama's commitment to the local economy, we wanted to get all the additional components from Peruvian suppliers. Having traveled and lived in Latin countries, we realized this would be a tough challenge.

Norman went supply-hunting in the Amazon. He could find conduit, but no connectors, 90° sweeps, J-boxes, etc. After visiting many vendors, he found some six-gauge stranded copper wire resembling the THHN type used in the US. He reported that there was some 10-gauge/3-wire cable that we suspected would have a wet-location rating. He also discovered a ground rod. That was it for locally-sourced components. We would have to round up all the other hardware, right down to the last ground-rod connector.

The camp was well stocked with tools. The only thing missing was a good multimeter. We would need one capable of reading the inverter's modified square-wave output. We also had to test and troubleshoot generators, so we ordered a Beckman "true rms" meter.



Above: The twelve PV modules racked and on their way to the top of the tower.
Below: Charlie and Felicia Cowden.

Above: Raphael installs and wires the PV modules. Below: Charlie Cowden applies shrink tubing to a soldered cable end.

We contacted the mail order company for details about the system they had sold to Yacumama. It was a “dead stock” kit that allowed no alterations for application or location. No one at the mail-order house even recalled the purchase.

The kit contained Siemens M-75 modules, but higher voltage M-55’s would have been better for such a hot climate. The kit had a Wattsun tracker, but we could only use the frame because of the rain forest’s fifty foot canopy. These were expensive mistakes.

Batteries — Lost in the jungle?

A physical inventory of the kit revealed that only six out of twelve of the 740 AH 2 volt cells had reached Peru. This was a real show-stopper for a 24 V system. After a lot of detective work, we found out from the mail-order company that the missing twelve 2 V cells had “fallen through the cracks” and were never sent. The six cells shipped to the Amazon were sold by the mail-order company as “spares”.

We could not simply buy a replacement set because of the shipment time. The installation date was moving closer. We searched desperately for batteries available in the Amazon, but the effort proved futile. Two weeks before leaving, we decided to make temporary use of two 12 Volt 270 AH marine deep-cycle batteries already at the camp. The $4,640 invested in the kit’s batteries and spares yielded nothing we could use.

Away we go

It took five different flights to get from Lihue, Kauai, Hawaii to Iquitos, Peru. Unable to ship supplies ahead of time, we brought them with us. Peru customs officials did not appreciate the “suspicious articles” they found in our bags. They confiscated equipment, assessed duties and made us pay fines, but in the end, it all worked out. The day after reaching Iquitos, we traveled 90 miles up the Amazon to Yacumama Camp. Upon arrival, we made a quick inspection of Norman’s tower. The next day we began work.

The success of PV systems at remote sites depends on local expertise, responsibility and stewardship. We wouldn’t be able to hop a plane to Peru every time Yacumama’s system had a glitch. If the system failed, it would be abandoned, throwing more money down the drain. To insure that the system would perform as needed, we recruited Rafael, the camp’s mechanic, to assist with installation. In the process, he could learn how to operate, maintain, troubleshoot and service the equipment.

An uplifting experience

We decided to assemble the PV array on the ground and raise it as a unit. The tin roof on the building looked

too flimsy to take much tramping around during installation.

Knowing all too well how fast our steamy Hawaiian climate rusts metal, we predicted that the galvanized hardware wouldn't survive the heat and humidity of the Amazon. We replaced it with the stainless steel hardware kit offered by Wattsun, which provided the needed corrosion resistance.

We wired the array with tin-plated #10 type USE. Minimizing voltage drop was critical. We divided the "normal temperature rated" modules into two sub-arrays. Combined wire voltage drops from the modules to the batteries were kept below 2%.

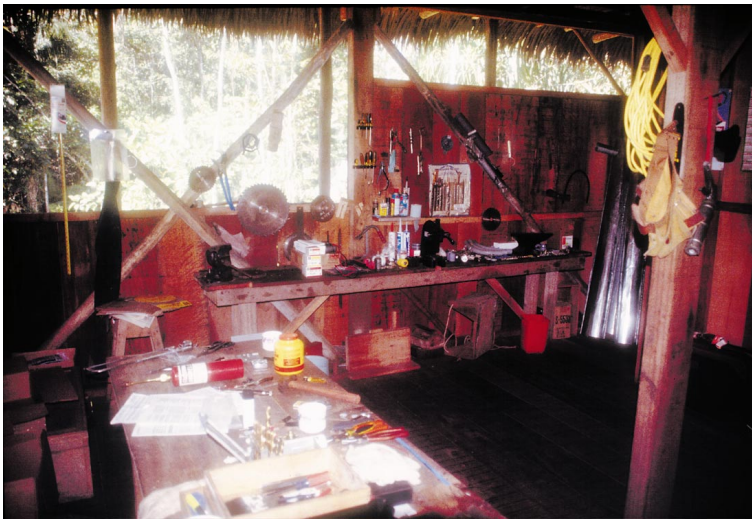
Norman Walters co-ordinated the workers who raised the completed array. He had told us earlier that the local men were at ease working high in the forest canopy. It took a well-organized group effort to hoist the twelve-module array up into the Amazon sunshine.

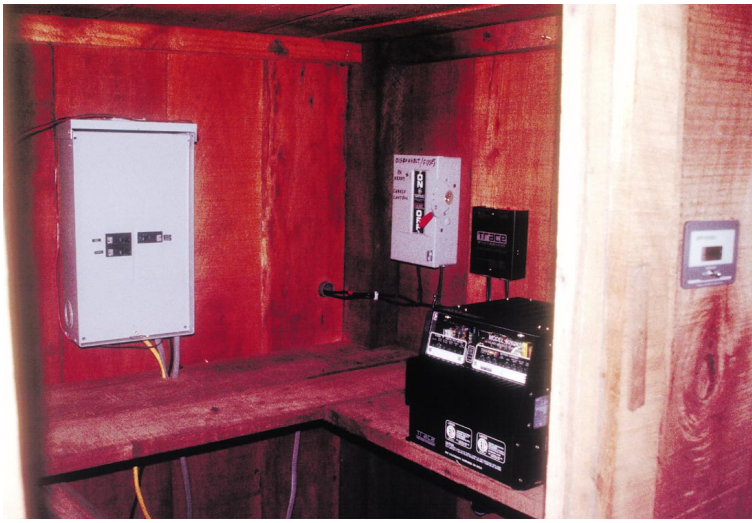
Once the array was on the roof, the job became routine. We took great pains to weatherize the system. Corrosion is the most common and hardest failure to detect in aging PV installations. We were determined to prevent it. Single conductors running from the array to the roof's plastic J-box were sealed with compression connectors and silicone caulk. We ran conduit into the equipment room. We used soldered lugs wherever possible and covered them with marine-grade heatshrink tubing. Bare wire-ends and crimp connections were treated with de-ox, then wrapped in rubber splicing tape.

The rest of the system

Although I was told that the site had ample sunshine all year round, Yacumama appeared to be the perfect application for the Trace inverter's standby charging system. The camp's four 120 vac generators had been working hard for the last eighteen months. All were priced in the moderate-to-cheap range and it showed!

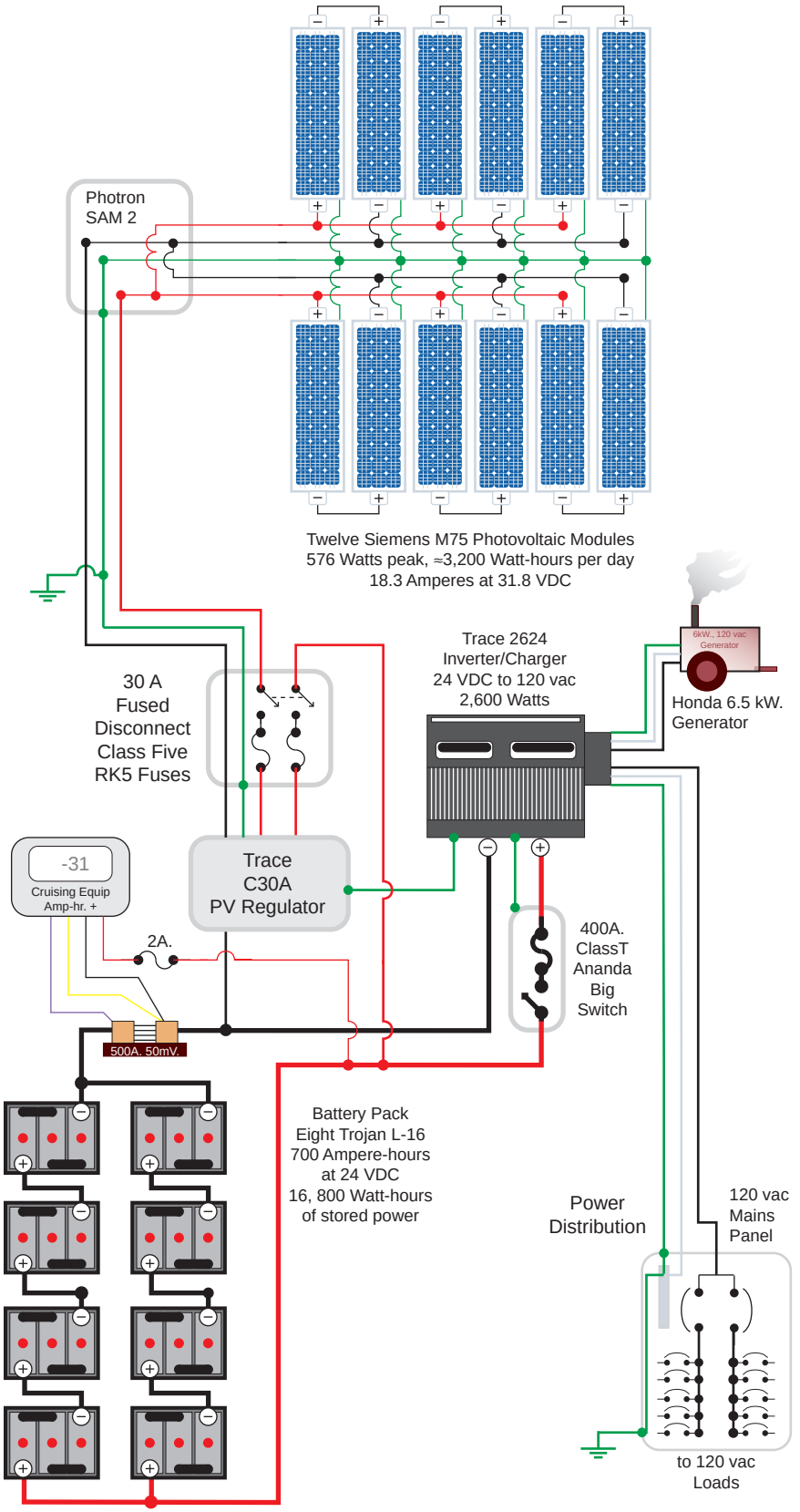
The two 5 kilowatt generators were wired to deliver a single leg at 120 volts. They were barely able to sustain a battery charging current of 15-17 amps. A quick check with the Beckman meter revealed that the peak output voltage was low. Next we tested the 11 kW generator. It could charge at just over 30 amps but not without a deafening roar. The 1 kW Yamaha bogged down under load and couldn't deliver even 8 amps. We bought a new Honda because they are readily available, even in the Amazon, and can maintain a high AC peak voltage under heavy loads. A transformer-based charger such as the one in the Trace inverter loves high peak volts.





Top: Yacumama's workshop.
Center: The power room with disconnects and inverter.
Bottom: Local kids check out the visiting gringos.

Yacumama Lodge's Photovoltaic System



Too hot to trot

Our worry about the effect of high temperature on the Siemens M-75 panels was sadly confirmed during system test. The intense heat sapped their peak power voltage. Current tapered off as the modules got hotter, dropping from 18 amps to less than 13. We confirmed this by pouring a couple of buckets of cool water over the modules and, sure enough, the current would rise. We noted the same effect with passing clouds — current would increase as the modules cooled. The Amazon's heat was too much for the 33 series-cell M75 modules. Use modules with 36 series-connected PV cells in hot climates.

Instrumentation

We installed a Cruising Equipment Amp-hour+ meter. This instrument makes it easy for the camp's crew to determine charge and discharge rates as well as the battery's state of charge. Easy to understand, the meter helped educate everyone about the basics of power management. We ran various tools, lights, and other appliances and watched the meter. This exercise is always an eye-opener. It shows exactly how we use power.

Smoke test time!

It is always an exciting moment when the last bolt is cranked and the switch is thrown. This was no exception. The lodge's AC wiring was soon in and we could retire the gas lanterns. At this point, we found that the system in place could meet lighting needs if we used the Osram or Sylvania compact fluorescents.

Future plans

We tentatively plan to enlarge the power system to support refrigeration, probably some Sun Frost units. A small pump may also be needed to move rainwater from tank to tank.

The battery problem remains unresolved. The six existing 2 V cells have been sitting unused in the jungle

Kit System including:

- 12 Siemens M75 PV Modules
- Trace 2624SB Inverter
- 8 Trojan L-16 Batteries
- Wattsun 12 Module Tracker
- Cruising Equip. Amp-hr+ Meter
- Trace C30A PV Controlller
- Ananda 400A Fused Discon.
- PV Disconnects & Breakers
- Battery & Inverter Cables

kit subtotal	$9,027

Other Essential Items	*Cost*
Beckman 2020 DMM	$268
Compact Fluorescents	$130
Lightning/Surge Protector	$117
Fuses and Misc. Hardware	$68
Wire	$79
Conduit and Fittings	$56
125 amp 120 vac Load Center	$50
Additional Circuit Breakers	$30
Battery Hydrometer	$18
essential item subtotal	$816
total now spent	$9,843

Future System Expansion	*Cost*
8 Siemens PC4 PV Modules	$3,360
8 Trojan L-16 Batteries	$1,520
8 PV Module Rack	$345
Trace C30A PV Contoller	$90
Fused Disconnect	$82
estimated expansion cost	$5,397
total including future expansion	$15,240

#	*Appliances*	*Run Watts*	*hours /day*	*W-hrs /day*	*%*
2	Lodge Kitchen Lights	15	8	240	13%
4	Dining Area Lights	15	4	240	13%
8	Bungalow Lights	15	2	240	13%
1	Lodge Kitchen Light	20	8	160	9%
1	NiCd Battery Recharger	11	12	132	7%
2	Bunkhouse Lights	15	4	120	7%
2	Employee Rec Rm Lights	15	4	120	7%
2	Manager's House Lights	15	4	120	7%
1	Blender	400	0.25	100	5%
2	Bathhouse Lights	15	3	90	5%
1	Dock Light	7	10	70	4%
1	Employee Dining Lights	15	4	60	3%
2	Buffet Line Lights	15	2	60	3%
1	Employee Bath Light	15	2	30	2%
2	Bathhouse Lights	15	1	30	2%
1	Office Light	15	1	15	1%
	Consumption Estimate — Watt-hrs per day			1827	

	Future Appliances	*Run Watts*	*hours /day*	*W-hrs /day*	*%*
1	Sun Frost F10 Freezer	55	16	880	44%
1	Sun Frost R19 Refrigerator	55	12	660	33%
1	Water Pump	240	2	480	24%
	Consumption Estimate — Watt-hrs per day			2020	

for nearly two years. Their capacity had probably been reduced by sulfation and humidity. Additional new cells would be prematurely destroyed by installing them in the weakened pack, so we decided to replace all the batteries. A refund from the mail-order company is on its way and will probably be invested in Trojan L-16s.

Frustrations

Lack of planning caused the frustration we experienced during the Yacumama solar power installation. Before we complain too loudly, we must acknowledge that the choice wasn't all bad. It helps to have a pre-designed package that eliminates the time-consuming sort through a menagerie of separate and possibly incompatible panels, batteries, connectors, cables, shunts and fuses. The downside to such a kit is that an inexperienced consumer assumes that a PV system is just like a generator; they can buy it and plug it into the side of the house.

First-time PV system buyers know that there is some assembly needed, but few realize how big the job is. Nor do they understand all the little subtleties required to create a safe and effective system to meet their needs. People think that installing a PV system is on the same scale as putting together a high-quality

stereo. It is a rare novice indeed who understands WHY one has to crimp, solder and shrink-tube battery cables in a humid climate. And you can hear the yells clear to Hawaii when a remote-site builder discovers only too late that the cable supplied doesn't fit the voltage-drop requirements.

A PV installation serving a camp in the Amazon is very different than one for a Northern Californian ranchette or a home on the west Texas plains. First-time power system buyers often don't know that standard kit components might not fit their location or application. They don't ask vendors for more appropriate substitutions. In PV, you can't assume that one size fits all. The end result is a less-than-satisfying installation and a disillusioned user.

Whoops, wrong voltage!

In Yacumama's case, the camp owner bought unsuitable panels, an unnecessary $1,200 tracker that now sits idle, and additional storage batteries that are incompatible. The inverter creates 120 vac, 60 Hz in a country that runs on 220 vac, 50 Hz.

Now the camp faces the dilemma of either purchasing a new 220 volt inverter or having to import everything from light bulbs to blenders. Failing to allow for the different electrical standards of non-US countries has created an unnecessary and costly headache.

We are emphasizing the results of a "blind" PV purchase because it is perhaps the most common mistake made by self-installers. We are not accusing the consumer of being foolish or lazy, nor the catalog suppliers of being unethical. Equipment variations are detailed and difficult to describe over the phone. Both the supplier and user often have to make an overwhelming effort to undo or patch up mistakes. What is the answer? Planning!

Cutting expenses by not using an experienced PV system designer will produce an inefficient system that ends up costing more.

On the positive side, Yacumama's system works. Occupants of the Lodge now have lights without the kerosene smell or the annoying whirr of a generator. The high-quality system components should stay trouble-free for for a very long time. When Yacumama receives the right set of batteries, its PV system will be healthy and strong.

Some suggestions…

We have several recommendations for people considering the installation of a solar power system. The main issues are: determining load size, choosing the correct components, purchasing and shipping the components, and proper installation. If you do not

Yacumama Lodge

Yacumama Lodge is a jungle camp-hotel deep in the Amazon basin of Peru. It is a part of a larger effort to preserve the rain forest on a long term, self-sustaining basis. The camp itself is a resort where visitors can experience the rain forest in a safe, comfortable and healthy environment while making a minimal impact on the natural setting.

The Yacumama camp covers approximately seven thousand acres. It is located in a remote, sparsely populated forest area 90 miles upstream from the city of Iquitos. Visitors can reach it by boat in roughly four or five hours. The land was purchased three years ago by Lawrence Bishop, who completely designed the camp. Fifteen guest cabins and another seven for resident staff are centered around a main lodge. Lawrence recruited indigenous Amazon residents for camp staff and construction crew and built the camp using native building techniques; simple platform houses with thatched palm-leaf roofs.

Norman Walters, the construction supervisor and partner who lives at the lodge full-time is a multi-talented artist. The buildings showcase his ability. The camp's main guide, Esteban, creates traditional art pieces that adorn the main lodge. They mingle with a variety of artifacts from Lawrence Bishop's tribal art collection. Every piece of furniture is sculpted from natural local resources, with some exceptions such as mosquito nets and Western-style mattresses.

For two months a year, the Amazon floods, turning the forest into a vast lake. Buildings here must be set up on raised platforms to avoid being washed away during the wet season. The annual drop in water level from flood stage to low ebb is roughly twenty feet. This water-level fluctuation governs all aspects of life along the river. The lodge's entrance has seven levels of tiered docks to accommodate boats throughout changes in seasons and water levels. Elevated covered walkways connect all the buildings so that people can walk around camp and stay dry even during heavy rains.

Yacumama's builders have paid an amazing amount of attention to detail. Ingenious examples include simple wooden pulleys with weights that are mounted on doors to make them shut automatically. This keeps keep the mosquitoes out. To prevent termite infestation, Yacumama's staff mounted inverted metal cones covered with tar on the foundation supports. Termites can't get past these barriers since their bodies can't make the ninety-degree bend required. All the buildings have double sets of screen doors to exclude flying and crawling insects. Cabins are sited so that each is away from its neighbors; completely surrounded by the sights, sounds and smells of the jungle.

Service buildings have corrugated tin roofs to provide a rainwater catchment system and are carefully hidden. Photovoltaic modules provide electricity. Water is heated by the sun. Yacumama's caretakers grow fresh vegetables in two garden areas and raise chickens for meat.

The camp's menu includes fresh fish caught in nearby rivers and lakes. They make their own tofu and prepare healthy meals in a kitchen that would pass any American health inspection with flying colors. All organic garbage is composted. The toilets have their own septic systems and leach fields. The laundry is washed in fresh rainwater and hung in a dry sauna room.

The camp staff have provided medical and educational supplies for residents within the surrounding four hundred square miles. They have built two medical clinics, three schools and four fresh water wells. In turn, local people contribute their knowledge about the forest and how to live safely in it. The exchange not only enriches the visitor's experience, but is essential to the camp's existence.

Lawrence Bishop and Norman Walters created Yacumama in order to stimulate the local economy by tourism rather than by destroying the forest. Long-term preservation efforts will only succeed when maintaining a pristine forest is more profitable than harvesting its resources. The idea is to use good old fashioned capitalism to free rainforest conservation from dependence on handouts by the government or private benefactors. The camp is nearly complete and has been accommodating guests for over six months.

For further information, contact Eco Expeditions at (800) 854-0023 or (305) 279-8494.

Above: A view of part of Yacumama Lodge from the tower that holds the photovoltaic modules

understand these issues, you must learn or enlist the aid of someone who does.

Load size is the number one consideration. High-demand appliances such as freezers require more power system hardware. Design your camp/building to use energy efficient appliances! Average consumption levels are not difficult to calculate. The number of required PV panels and batteries can then be determined. The size and type of inverter that is most appropriate is also defined by the appliances. At this point, you can decide if photovoltaic power is affordable and if it will be enough to meet your needs.

Site temperature, hours of sunlight and humidity are three important environmental factors that influence the choice of system components. Political factors must also be considered. Inquire into the physical logistics of shipping products and finding replacement parts. It is always best to buy from a supplier who understands and cares about your application. In a remote location, the installer should have acquired all of the necessary pieces at the beginning of the job.

Finally, proper installation will insure a continuous flow of power with minimal or no failure. A permanent resident or staff member should be trained to understand the system. System monitors should be placed in a convenient location for easy viewing. Difficulties can be identified before they become problems.

These planning and installation steps may sound difficult to the novice, but they make the difference between a system that meets your needs and an expensive nightmare. For applications such as an eco-tourism camp solar power is the ideal power source. It is healthy, environmentally friendly, quiet, more cost effective than a generator and largely hassle-free. The learning experience is not that difficult and we have found it quite rewarding. We encourage the use of solar power. With proper planning, the lights will be on in your remote corner of the world, and you will be a happy camper.

Access

Charlie & Felicia Cowden, Hanalei Solar, P.O. Box 790, Hanalei, HI 96714 • 808-826-9000

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HP Survey Results

Sam Coleman

The first results are in from *Home Power's* Renewable Energy Survey. Over three hundred readers have responded so far. Of these, 66% are renewable energy (RE) users, while 53% are connected to the grid, and 20% use both RE and grid power. Household size varies from 1 to 10 people, with an average size of 2.6 persons per household. Most homes (74%) have three people or less. The geographical distribution of respondents is shown in table one.

General Results

Of the RE users, 96% use solar, 20% use wind, and 7% use hydro. The cost of a renewable energy system ranges from $200 to $300,000 dollars. The latter is for a grid intertie system in England. System cost averages $8887. Most RE users (95%) installed their own systems, while 11% have used a professional installer at some point.

Table 1

Region	*Respondents*
Northeast	10.3%
NY/PA	4.2%
Mid-Atlantic	3.0%
Southeast	4.0%
North Central-East	4.8%
North Central-West	7.0%
Central	4.8%
South Central	6.4%
Mountain	17.0%
West	34.8%
International	3.6%

The age of RE systems averaged eight years, with the oldest being seventy-nine years and the newest being less than one year old.

There are 4.6% of RE users who sell power back to the grid. The average rate they received is 8.1¢ per kilowatt-hour. The lowest rate is 2¢ per kilowatt-hour, while the highest is 15¢ per kilowatt-hour.

Table 2

	RE Use KwHrs/Day	*RE Cost ¢/KwHr*	*Grid Use KwHrs/Day*	*Grid Cost ¢/KwHr*
Minimum	0.1	2.3	0.1	2.1
Maximum	95.0	351.0	100.0	23.0
Average	3.6	69.9	18.9	9.2

Table 2 summarizes the cost and usage figures for both RE and the grid. RE cost is prorated over fifteen years.

RE and Grid Ratings

Our respondents rated both the grid and renewable energy systems for satisfaction, reliability, and environmental effects. The results are shown in Table 3 and Figure 1. For all these categories, five was the highest possible rating, while one was the lowest.

Future Renewable Energy Scenarios

We asked our readers to rate four future RE scenarios from one to five, with one being the lowest rating and five the highest. The four scenarios were:

- utility scale renewables on grid
- the utility owns the off-grid RE systems and sells the energy to us
- we own the RE systems and sell to the utility
- we own the RE systems and are disconnected from the grid.

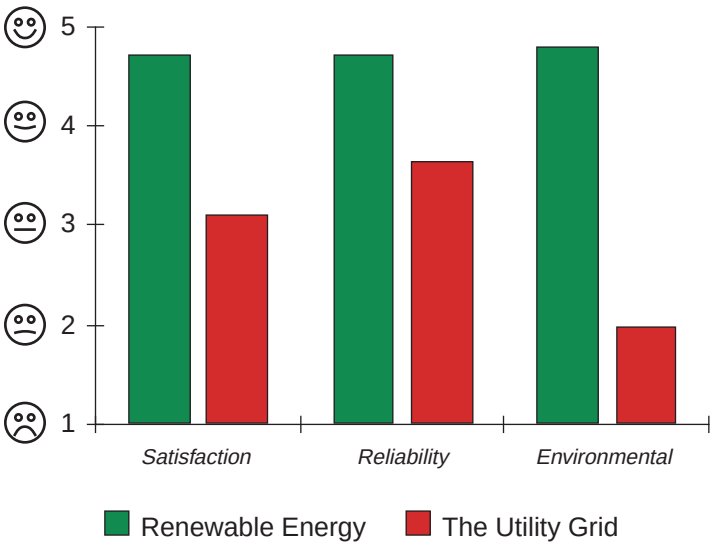
Figure 2 shows the ratings distribution for the four scenarios as a percentage of respondents. Table 4 shows the average rating for the four scenarios.

Conclusions

Today, renewable energy systems can supply as much power as you can use. They are, however, still more expensive, on the average than the grid. Some of this apparent expense is due to high cost, low-use systems such as cabins and vacation homes. Although solar is the renewable energy of choice, hydro and wind make a substantial contribution.

The comparison between the grid and renewable energy systems (Table 3 and Figure 1) shows that renewable energy is preferred over the grid in all three categories. This is especially true in the area of environmental effects. Even when we compensate for the thirteen percent difference in grid and RE usage this conclusion remains valid. *Home Power* readers still prefer renewable energy systems to the grid.

Figure 1— Average RE and Grid Ratings



In the future scenarios comparison (Figure 2 and Table 4), *Home Power* readers prefer private ownership of renewable energy systems to utility ownership by a two to one margin. The highest preference was given to private off-grid RE systems. The lowest was where the utility owns the off-grid system and sells energy to the consumer.

This survey indicates that our energy future lies with privately owned renewable energy systems.

Done yet?

Nope, the survey continues, so all of you readers who haven't yet sent in your survey please do so. Many thanks to the 330 readers who have already responded to this survey. See *Home Power* #42, page 16 for the RE survey article and form. If you want to read some of the great comments on the survey forms, then check out this issue's Letters to *Home Power* section on page 98. The raw data from this survey will be available on the Home Power BBS.

Access

Sam Coleman, c/o Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179.

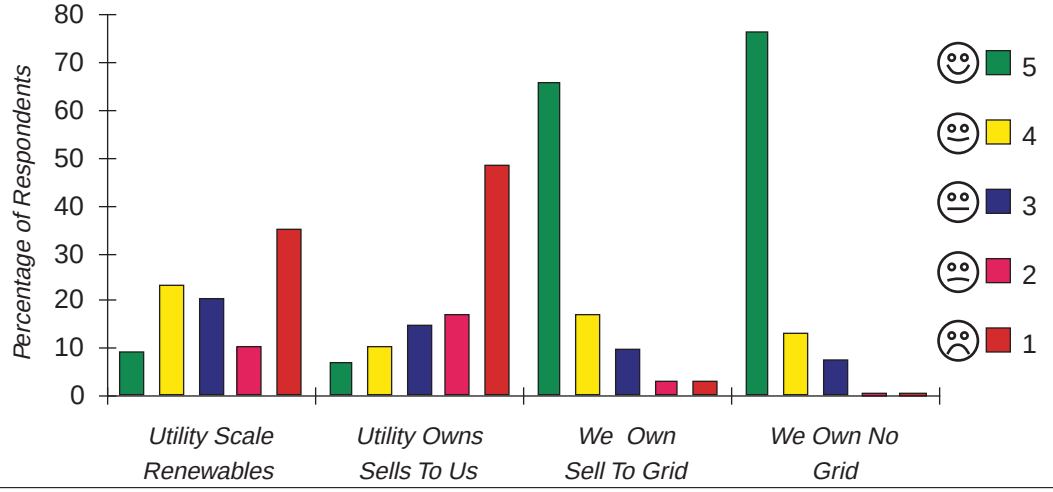
Table 3

	Renewable Energy			*Utility Grid*		
Rating	*Satisfaction*	*Reliability*	*Environmental*	*Satisfaction*	*Reliability*	*Environmental*
5	75.1%	79.0%	84.7%	14.3%	29.7%	3.5%
4	21.7%	17.3%	12.5%	28.6%	30.9%	8.1%
3	3.2%	0.9%	2.8%	27.4%	22.3%	19.1%
2	0.0%	2.3%	0.0%	13.7%	9.7%	20.9%
1	0.0%	0.5%	0.0%	16.0%	7.4%	48.2%

Table 4

	Utility Scale Renewables	*Utility Owns Sells To Us*	*We Own Sell To Grid*	*We Own No Grid*
Average Rating	2.61	2.10	4.39	4.63

Figure 2 — Home Power readers rate future energy scenarios



Above: Some of the thousands renewable of energy folks who braved the 105°F temperatures to attend SEER ‘94.

SEER ‘94

Richard Perez

On July 16th and 17th over seven thousand people attended Solar Energy Expo & Rally (SEER) in Ukiah, California. Renewable energy and alternative transportation were demonstrated by 184 exhibitors.

SEER ‘94 moved location from Willits to Ukiah, California. This year’s fair occupied a large state-owned fairgrounds, with attached racetrack for the electric vehicle events. The SEER ‘94 crew went all out producing the fair in a lavish manner. A Bergey BWC 850 wind generator on a sixty foot tower topped the scene. Everywhere electric vehicles whizzed from place to place. Photovoltaic modules went up everywhere around the RE booths, most of them were off-the-grid. Friday was “industry day”, with exhibitors swapping stories and attending meetings. Saturday the fair opened to the public and a flood of attendees washed over the fairgrounds. A complete issue wouldn’t hold the words to describe all there was to see and do. Here is our “photo scrapbook” of SEER ‘94.

Renewable Energy Events

SEER is always great for meeting all the different dealers, distributors and manufacturers of renewable energy equipment. The Home Power Crew set up our usual “home away from home” booth (complete with PV system, solar cooking, and working Optaphone radiotelephone!) at the fairground’s east end. We were in good company, surrounded by the folks who pioneered the use of RE in home-sized systems. Our

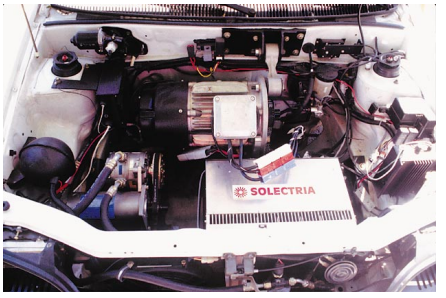
Below: The fairgrounds were so large that alternative transportation was widely used and appreciated.

Above left: The Bergey BWC 850 flies over the fair. Above inside left: Unisolar displays their new thin film PVs. Above inside right: Fairgoers mob Sunelco’s large booth full of RE goodies. Above outside right: Alternative Energy Engineering and AAA Solar teamed up to display deals in PV and solar hot water.

Above left: Anosh Mizany and the Solar Depot booth. Above center: The fellows of Southwest Windpower show off their radical new AIR wind generators. Above right: Home Power’s booth complete with PV-powered fountain, PV power system, solar cookers, radiotelephone, computer, and stereo — just like home!

Above left: Steve Willey of Backwoods Solar displays the gear he manufactures to Charlie Cowden, author of the article on page 6 of this issue. Above center: Suntools displays Phil Jergenson’s box beam creations — everything from electric vehicles to furniture (see the review of his *Box Beam Sourcebook* in this issue). Above right: Laurie Stone tells fairgoers about Solar Energy International’s educational opportunities. Below outside left: Joe Radabaugh displays his solar cooker kits in front of the demonstration straw bale house. Below inside left: Dave Doty and the monster power panel he built for the fair’s electric music system. Now that’s truly a “big switch”! Below inside right: A radical new, ultraportable, solar tube cooker (call Steve Cooper @ 510-654-4641). Below outside right: The new Sunflower active PV tracker from B.C. Solar.


Above outside left: The Horlacher City EV. Above inside left: The Horlacher creates a sensation at Home Power's booth. Above inside right: Roy Kaylor (20,000 Big Basin Way, Boulder Creek, CA 95006 • 408-338-2200) shows his VW electric conversion kits. Above outside right: PV-powered electric kiddie car sports a Cruising Equip. KW-hr meter complete with GPS location system (see text for techie details).

Above left: The Solectria Force EV uses Solectria's new AC drive system. This particular car is being tested by the US Air Force. Above center: A view under the Force's hood shows how little of the original Geo Metro's drive train remains. Above right: Every RE-powered farmer's dream — an electric tractor!

neighbors included: Backwoods Solar Electric, Alternative Energy Engineering, Offline, Integral Energy Systems, EarthLabs, Solar Energy International, and Sun Tools just to name a few. Every installing RE dealer loves events like SEER. They are able to get together with other folks who are actually installing systems and swap "war stories". The RE distributors love attending these events because they get to meet their dealers. Companies like Sunelco, Energy Depot, and Solar Electric Specialties all had large booths displaying all their capabilities. SEER is also the hot place for manufacturers to debut their new products. Several caught my eye.

New RE Hardware debuted at SEER

So much new gear showed up at this years SEER that I was hard put to even get a look at it all. What follows here is a description of the gear that I though might interest Home Power readers.

Statpower displayed their new microprocessor controlled battery chargers. These new chargers are powered by 120 or 240 vac and come in 10, 20, or 40 Amperes, 12 VDC output models. Being high frequency switching power supplies they are ideally suited for operation from an engine generator as well as the grid. I was amazed at their compact size and silent operation.


Above left: Bart Orlando's people-powered generator ran Saturday night's concert. See the article this issue about this manical machine. Above right: my favorite vehicle of the fair, a wooden trimaran by Secret Harbor Boatworks (707-743-1312)

Southwest Windpower had four of their new AIR turbines available for inspection. These micro wind turbines are as cute as a bug's ear. I had a long discussion with David Calley, one of AIR's designers. He stated his purpose as, "…to make wind power as easy to use as PV." These new turbines are ultra streamlined. They are made using the latest in high-tech carbon fiber materials, with a smooth-running, three-bladed prop. I have never seem this degree of detail in any wind machine much less a small 300 Watt machine. I ordered one on the spot and can't wait to fly it!

Cruising Equipment displayed their new KiloWatt-hour+ Meter for electric vehicles. This unit not only records data and is computer capable, but also talks to an optional Global Positioning System (GPS) receiver which locates the vehicle on the earth by using the GPS satellite radio system. Rick Proctor hooked the unit up to the kiddie car (shown top, right on page 21) in about ten minutes. The young man in the car drove it all about the fairground for about 45 minutes. Rick then dismounted the Cruising unit and plugged it into his notebook computer. Instantly we had a spreadsheet detailing the car's motion (latitude, longitude, velocity, elevation, and %grade) about the fairgrounds. The electrical portion of the meter recorded the car's power data (battery voltage, amperage, kiloWatt-hours consumed, Ampere-hours consumed). All the data was GMT date and time stamped. I was impressed at the instrument's accuracy, capabilities, and ease of use. The instrument sans GPS would make an excellent remote data logger for RE systems.

A new company, B.C. Solar (PO Box 1117, Laytonville, CA 95454 • 707-984-8203) showed off their active PV trackers called "Sunflowers". The units are available in single or two axis models, from eight to sixteen PV modules. Their claim to fame is ultra low power consumption with the tracker using two Watts per axis per day. The Sunflowers are powered by the system's main battery.

Electric Vehicle Happenings

The most amazing race was the 200 hp electric "lead-sled" Snowhite versus a 300+ horsepower gasoline race car. See the GoPower section of this issue for a description of this and other incredible races.

Personally, I had fun driving various EVs at SEER. I tried out the SunCoaster (see HP#42, pg. 48) and found it wonderfully well engineered. I loved all the instruments that measured all the car's various functions. I also got to try out the electric wheelbarrow pictured on page 41 of this issue. This wheel barrow had excellent intuitive handling and was used all day long hauling stuff and people about the fairgrounds.

Karen and I got to drive the Leed's Speedster on Ukiah's city streets and back country roads. See page 42 of this issue for a complete article about this car. Both Karen and I found that the Speedster had incredible acceleration and easily beat all the "gassholes" out of every stop light. At 40 mph, the Speedster was stable and steered well. The feeling of whizzing at high speed in such a low-to-the-ground, silent vehicle is indescribable and totally too much fun!

I also begged rides from two commercial electric vehicles. Bill Warf of Pacific Electric Vehicles (8500 Weyland Ave., Sacramento, CA 95828 • 916-381-3509) kindly gave me a ride in the Horlacher City prototype pictured in this article. We toured the streets of Ukiah in this very polished EV. This Horlacher has all the features of a conventional automobile — comfortable seating, safety belts, defroster, heater and silent, clean electric operation to boot! The Horlacher seems very well designed and made. This two seater is more than capable of getting about town with adequate acceleration, great brakes, and handling as precise as a Swiss banker.

I also got a short ride in the Solectria Force. This deeply converted Geo Metro had great acceleration and even boasted an air conditioner, a rare feature in most EVs. I got the feeling that the Force was capable of freeway travel at freeway speeds. The vehicle is larger than the Horlacher City and more powerful.

As the sun sets…

By Sunday night, everyone at SEER was sunburned, moderately dehydrated, and profoundly tired by too much fun. We stayed on Sunday night with a few other die-hard manaics. We were rewarded by the finest Mexican food I have ever eaten inside the USA, at a little place called "Super Taco" (506 East Perkins, Ukiah, CA). This SEER was like every other — a surprise and a joy. See you at the next SEER two years hence.

Access

Richard Perez, c/o Home Power, PO Box 520, Ashland OR 97520 • 916-475-3179 voice or FAX. Email via the HPBBS 707-822-8640 or via Internet: richard.perez@homepower.org

AAA SOLAR

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their 800 phone number)

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Barbecuing with Hydrogen Gas

Walt Pyle, John Dabritz, Reynaldo Cortez, and Jim Healy

Barbecuing with hydrogen is cleaner than using charcoal or propane because there's no carbon in hydrogen. When hydrogen burns, it emits only water vapor and traces of nitrogen oxide. No toxic pollutants, smoke, or particulates are released by a hydrogen flame. When hydrogen is produced by renewable energy, the water–to-fuel–to–water cycle can be sustained virtually forever!

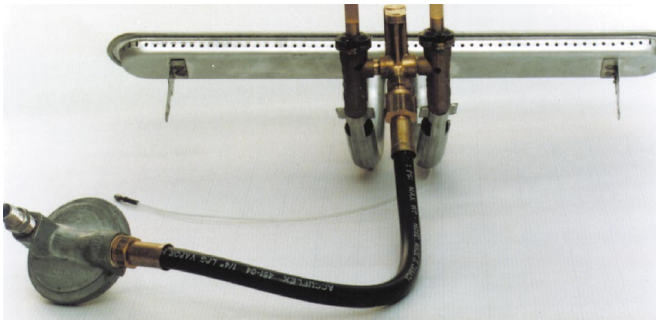
Above: The propane gas barbecue before modification

For generations, barbecue fires have been made from charcoal. Though we also have natural gas and electricity for cooking, these resources are largely based on fossil fuels and are not sustainable. PV produced hydrogen *is* sustainable. (See HP #39 to see how PV electrolysis is accomplished. Cooking with hydrogen also appeared in HP #33.) Air pollution from barbecues is becoming objectionable in densely populated areas. Outdoor cooking is very popular on hot summer days. Unfortunately, that's also when air quality is usually at its worst. Legislation regulating barbecuing has even been enacted in some areas.

Propane Barbecues

Propane barbecues are more convenient and produce less emissions than charcoal models. Propane also eliminates waiting while the coals get hot.

Above: By removing the cooking grill and lava rock support, you can see the stainless steel propane burner.

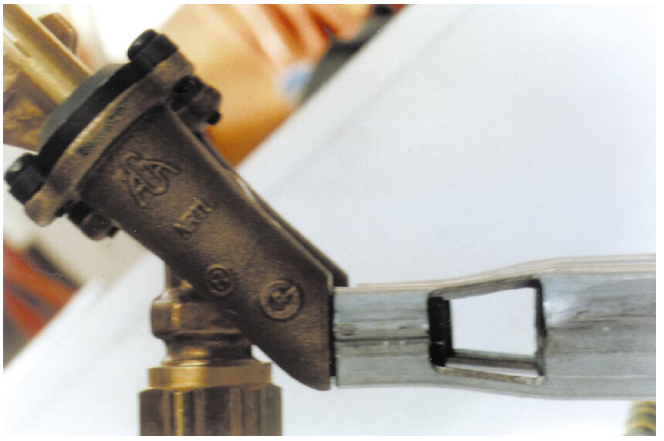


Above: The propane gas supply valves, burner, and pre-mix tubes, and pressure regulator.

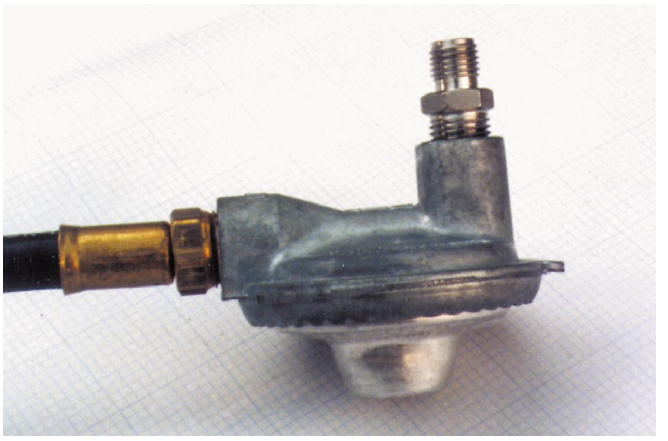
The propane burner is ignited by turning on the gas and pressing the piezo-electric igniter button. A spark ignites the fuel-air mixture escaping from the burner. The flame heats lava rocks, distributing the heat to the grill. Liquids that drip onto the lava will vaporize and burn, shielding the burner from contamination. After cooking is finished, the gas is turned off and the heat stops. The lava cools quickly to ambient temperature.

Gaseous fuel is safer than charcoal in some respects. For instance, there's no need to supervise the fire after cooking. You're less likely to start a fire when a gust of wind comes up and rekindles "dead" coals! There's also much less ash residue. Though propane flames emit carbon oxides and hydrocarbons, amounts are less than from charcoal. Better fuel-air mixing results in less smoke. Cooking time is also shorter with propane.

The propane flow to each burner is controlled by a valve and delivered to an orifice. The orifice limits the gas flow and produces a high velocity jet, which aids fuel-air mixing. The high velocity gas enters the pre-mixer, drawing air through ports on each side of the burner delivery tube.



Above: The propane burners installed in our barbecue use fuel-air pre-mixers.



Above: The gas pressure regulator with Swage lock tubing INLET pipe fitting.

Conversion of a Propane Barbecue to Hydrogen

We started with a two-burner Kenmore propane barbecue. It has 1451 square centimeters (225 square inches) of cooking area and is rated at 24,000 Btu (82 kW) per hour. Sears had it on sale for under $100.

We converted our barbecue by changing the burners and gas delivery tubes to prevent pre-mixing of the hydrogen fuel and air. Other parts of the barbecue were usable without modification. The covers, grill plates, gas supply line, control valves, pressure regulator, and piezo-electric igniter all worked as purchased. We will use the propane tank in a future hydrogen storage experiment.

Step 1. Feeding Hydrogen to the Pressure Regulator

Remove the pressure regulator from the propane tank. Attach 0.64 cm (0.25 inch) Swage lock stainless steel tubing to a 1/4 NPT fitting. This will replace the original pipe fitting on the “INLET” side of the regulator. We used stainless tubing, but copper or brass tubing and fittings can be used as well. They may also be easier to obtain at your local hardware store.

Set the hydrogen gas supply pressure to about 1 bar (14.5 PSIG) at the pressure regulator “INLET”. Most propane-type regulators are rated for 17 bar (250 PSIG) maximum inlet pressure. Do not exceed the rated value. Use safety relief-valves in the piping and storage tank so excessive pressure cannot cause an unsafe condition. A welding-type compressed hydrogen cylinder with two-stage regulator can be used to supply the pressure regulator. For safety, include a shutoff valve to isolate the hydrogen supply from the pressure regulator during idle periods.

Before we continued our hydrogen conversion, we wanted to try the barbecue on hydrogen in its “propane” configuration. We supplied the pressure regulator inlet with 1 bar (14.5 PSIG) pressure from the hydrogen tank and checked for leaks. Donning safety glasses, we turned on the control valve and pushed the igniter button. The fuel-air mixture in the burner and supply line promptly lit with a loud “BANG” that resembled a firecracker! We weren’t surprised. The pre-mixed gas and air was flammable. The velocity of a hydrogen flame is much higher than that of propane. The flame moved backwards against the hydrogen flow. It traveled from the igniter at the burner pre-mix outlets to the orifice at the mixer. The flame burned freely on the open jet of hydrogen coming out of the orifice, heating the pre-mix tube instead of the burner.

The hydrogen diffusion burner and gas distribution plate are designed to prevent the pre-mixing of hydrogen with air. In a gas diffusion burner, fuel is burned without premixing the fuel (hydrogen) with air.

Below A close-up of Hydrogen Burner Showing Gas Diffusion Ring. By coating the surface of the burner pores with a catalyst, nitrogen oxide emissions can be reduced.

Pure hydrogen fuel passes out through the porous surface of the burner. The hydrogen and oxygen from the air then mix within the outer pores of the burner. This prevents flash-backs and keeps the flame from propagating from the outer burner surface back into the fuel supply.

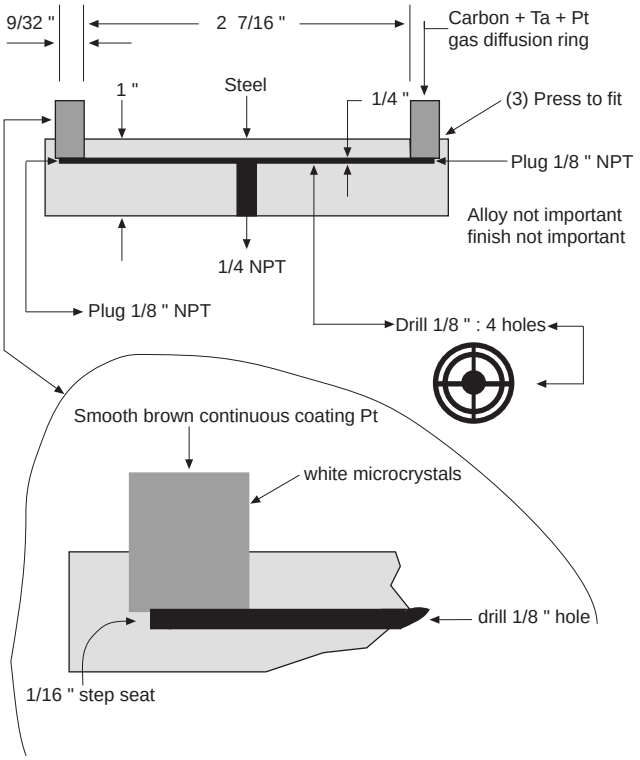
Step 2. Making The Burner
Machining the hydrogen gas distribution base from low carbon steel requires the following steps:

1) For the gas diffusion ring, cut a circular groove with a shoulder step on the outside. The step prevents the ring from being pressed all the way to the bottom of the circular groove.

2) Drill two long holes completely through the steel base at 90 degrees to each other. The holes will connect the gas feed fitting at the center of the burner to four different locations around the circular gas distribution groove.

3) Tap the outermost ends of the four holes for 1/8 NPT pipe plugs.

4) Tap the center gas feed point of the base to accept a 1/4 NPT-to-stainless tubing supply line fitting.



The burner gas diffusion ring is made from tantalum foam tubing. The rectangular ring segment can be cut with a table saw or chop saw. Another source of the tantalum burner-ring material is automotive air-bag deployment shell diffusers. Besides tantalum, other high temperature foam materials are also available from Ultramet (see access).

The burner ring is plated with platinum catalyst. Attach the ring to the negative (cathode) lead of a low voltage D.C. power supply. Attach the positive (anode) power supply lead to a platinum wire. Immerse the ring and wire in an electrolyte solution. The solution is made by dissolving 1 gram of platinum in about 20 ml of aqua-regia and diluting to 100 ml with distilled water. Apply 1–2 Amps of current for several hours until the surface of the tantalum ring is coated with a thin layer of platinum.

Press the burner ring into the gas distribution base using a mechanical press. A completed burner is shown in the photo. The lava rocks have been removed from one side for clarity.

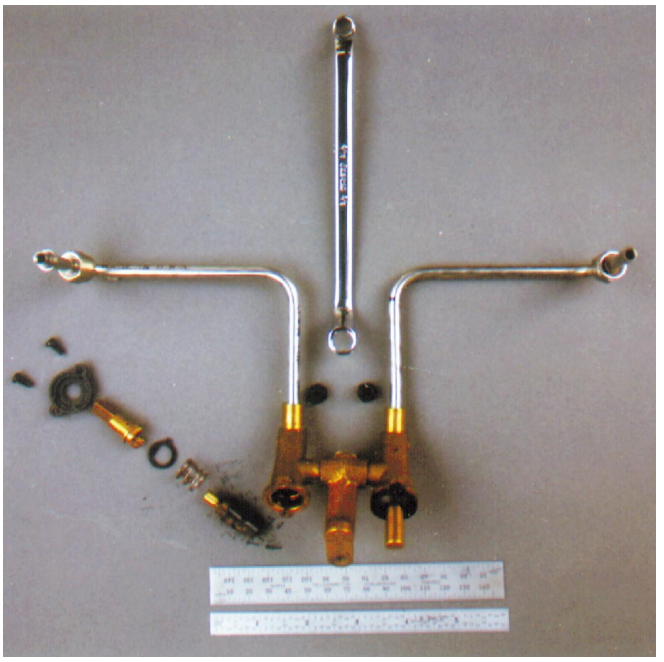
Above The burner installed in barbecue

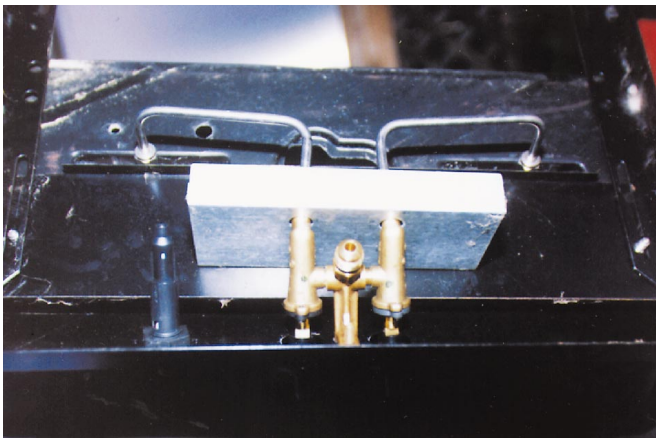
Step 3. The Hydrogen Delivery Lines
Extend the hydrogen gas delivery lines from the flow valve to the burner with two stainless steel “L” shaped 22.5 cm (9 inch, 0.25 inch diameter) lengths of tubing.

Remove the jets from the valve body using a 10 mm (3/8 inch) box end wrench. Insert the stainless tubing lengths in the former jet holes. Before soldering, disassemble the brass flow valves and remove heat sensitive components and lubricant. Position the stainless tubing sections securely and silver solder them in place. Be sure to put the sheet metal support bracket over the tubes before soldering them into the valve bodies. Also check that the bent sheet metal tabs face away from the valve bodies.

Clean the valve bodies after soldering. Reassemble the heat sensitive stem, spring, and plastic detent retainer. Use silicone stopcock grease as seal and lubricant.

Step 4. Install the Igniter
Install the piezo-electric igniter’s insulator and high voltage lead near the new hydrogen gas diffusion





Above: Remove the jets and valve components, before silver-soldering stainless tubing.
Below: The barbecue's underside with burner hydrogen delivery tubes & valves.

burner. It will be used to light the burner. Bring up a ground lead alongside to position the spark gap near the burner gas diffusion ring.

A loud "POP" will occur at the moment of ignition. The hydrogen-air mixture ignites at the spark and will propagate to the burner surface. Thereafter, combustion will occur primarily in the pores of the burner ring.

Safety First!
Hydrogen gas testing should be done outside or in a well ventilated area. Only pure gas should be used or stored. Remember, though hydrogen diffuses rapidly away from a source when released, it's flammable over wider ranges of air-fuel ratios than propane. It must be handled with respect. Hydrogen safety precautions are given in articles appearing in HP #34 and #35.

Step 5. Testing
Use a soap solution to leak test the tubing connections, pipe fittings, valves, and regulator. Test with about 1 bar (14. 5 PSIG) hydrogen gas pressure.

We also tested the completed burner for heat release and nitrogen oxide emissions. A NOx meter was used to sample the burner's hot exhaust gas plume at different positions. We used a Bacharach NONOXOR II with a range of 0-2000 parts per million (ppm) NOx. These meters are used for field testing engine exhaust for emission compliance.

Above: Test setup showing barbecue, NOx meter at 50% hydrogen flow (86 ppm)

At the "LOW" gas valve setting, NOx levels varied from 60-80 ppm in the flame 5 cm (2 inches) above the burner ring. At 12 to 30 cm (5-12 inches) above the burner center, NOx varied from 2 — 6 ppm.

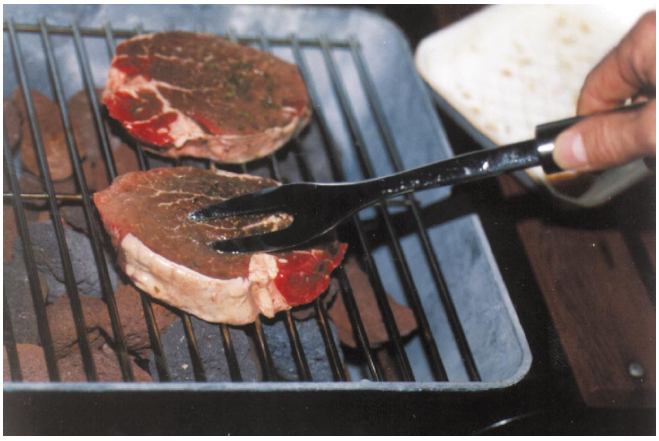
For "HIGH" hydrogen flows, NOx levels varied from 80-160 ppm 2.5 cm (1 inch) directly above the burner ring. At 30 cm (12 inches), the NOx dropped to 36-47 ppm. The NOx increased with increasing flow at all positions. The NOx level also increased as the probe was moved closer to the burner.

At about 50% flow, the cooking temperature was just about right. Fortunately, the heat release can be set to the proper level for cooking on the lava with no further changes to the hydrogen flow valve and valve ports. We reinstalled the rock and food grills and made a NOx measurement at the cooking grill surface above the burner and rocks. We recorded 65-90 ppm at 50% flow and 180-260 ppm at "HIGH" flow.

Background NOx released by the hydrogen burner exposes the cook to no more than 2 ppm. The eight hour time-weighted average set by the U.S.

Occupational Safety and Health Administration (OSHA) is 25 ppm NOx. For reference purposes, our natural gas stove burner ran at mid-range with 15–25 ppm NOx at 2.5 cm. (1 inch) above the natural gas burner flame.

Cooking Tests were conducted: Hydrogen Steaks!!
We tried steaks for our first hydrogen barbecue as seen in this picture.



Above: Cooking Steaks on Hydrogen Gas Barbecue

Endurance testing is needed to determine the lifetime of the burner. Some burner ring "break-in" has occurred. After several hours of operation, the sharp edges of the gas diffusion ring have become rounded by excessive heating. Whether this will stabilize remains to be seen. Lifting the rock grill higher above the burner ring will probably reduce the reflected heat reaching the burner ring from the glowing lava.

Possible Future Improvements and Measurements
1) Coating the steel base to prevent rust caused by combustion water condensation at startup and "LOW" hydrogen flows.

2) Venting the lid to prevent the buildup of an explosive mixture. This could occur when the gas is "on", the cover is closed, and ignition has not yet occurred. An interlock could be used to prevent hydrogen from flowing to the burner when the barbecue cover is closed and the flame has not yet been lit.

3) Measuring the flow rate of the hydrogen gas delivered to the burner at different valve settings.

4) Measuring the temperature of the burner surface at different hydrogen flow valve settings.

Acknowledgements
Ultramet, for the foam tantalum and silicon carbide tubing samples.

A&K Machine Shop, Richmond, California for machining the burner gas distribution plate.

Access
Authors: Walt Pyle WA6DUR 510-237-7877, John Dabritz 510-242-5366, Reynaldo Cortz 510-237-9748, and Jim Healy WH6LZ 510-236-6745

Diffusion Burners for Hydrogen: Fraunhofer-Gesellschaft Institute for Solar Energy Systems Tel: (Freiberg, Germany) 49-761-4014-0 Ext. 164 or 210. FAX: 49-761-4014-100

Diffusion Ring Tubing: Ultramet, 12173 Montague Street, Pacoima, CA • 818-899-0236 FAX 818-890-1946

Chemical supplies (platinum powder and wire, aqua-regia): Aldrich Chemical Co., 1001 W St Paul Ave, Milwaukee, WI 53233 • 800-558-9160

Ananda Power Technologies

camera ready
7.15 inches wide
3.2 inches high

on negative

Statpower

camera ready
7.5 wide
4.5 high

Economy Solar Shower

Homebrew

Bob Battagin

After a hard day's work, I look forward to a warm wash-down in my backyard solar shower. I get a special feeling from using water heated by the sun and recycling it directly to the grasses and native plants in my yard while standing (dare I say it?) buck-naked in Nature's glorious outdoors. The fresh evening air, solar-warmed water, singing birds and sweet-smelling garden soothe away the day's cares and concerns.

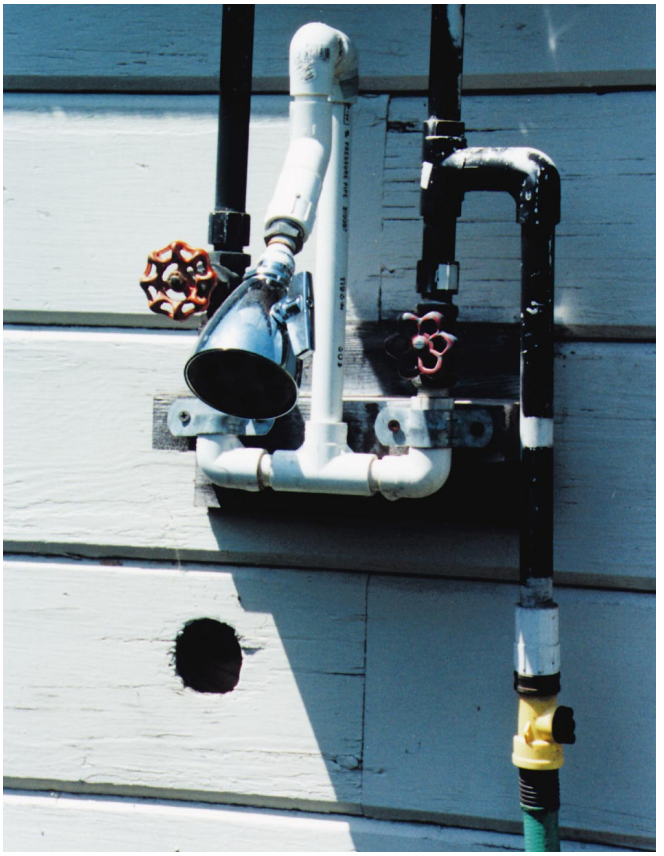
Here's a solar shower that uses simple, inexpensive components for a low-impact, relaxing wash.

Technical matters

A re-used water heater and a plexiglas greenhouse are at the heart of the shower. I painted the 15 gallon tank flat black to optimize heat absorption and mounted it on the edge of my garage roof (see photo). I recommend a squat tank to lower the center of gravity of this heavy component. I positioned the tank for adequate support and good solar exposure.

Since my system is fed by a public water main, the tank could have been located above or below the shower-head. For a gravity-fed or low-pressure source, I would need to mount the tank above the shower-head.

The hothouse is made of rigid plexiglas attached to a simple wooden framework enclosing the water tank. My original design had 3 mm. polypropylene covering the frame, but sun-induced deterioration and wayward basketballs precluded its long-term use. I use the handle on top to lift the hothouse off the tank when I clean the inside of the plastic once a year.



As with ordinary water heaters, cold water enters at the bottom of the tank. When heated water is drawn from the top, cold replaces it underneath, minimizing mixing. I supply the system via a simple threaded adaptor and a garden hose. A dedicated supply line would be even better.

Note that incoming cold water is directed not only to the tank for refill, but also to the shower-head. After a sunny summer day, the water is often so hot that I need to add some cold to make it comfortable. In my part of California, this system is usable for approximately seven months of the year — late spring through early fall.

Heated water is forced by ordinary water pressure out of the top of the tank when I open the valve. I've used globe valves to control flow and PVC pipe for all interconnections. As with many projects of this sort, you may use other valves and/or pipes, depending on what's in your odd parts bin.

Hot and cold water combine in a manifold formed by a pipe "tee" which directs the mix into the shower head. In my installation, the shower head ended up a bit too low (poor planning). The photo shows that I looped it back up a foot or so to raise the shower head height. I found this more convenient than showering on my knees.

More technical matters

The shower pan is twelve bricks laid neatly on the ground and surrounded by grass and ground-cover. It drains directly into the earth.

Less technical matters

I use a minimum of soap and shampoo when washing. After seven years of operation I've noticed no adverse effects from the use of this shower. Quite the contrary; all the plants in its vicinity have flourished from the regular watering.

I'm fortunate to have a private spot in my backyard for the shower. Look for shielding by fences, walls, trees, shrubs, etc. to help you locate yours. You may need to plant a new shrub or install a bit of reed screen to satisfy either you or your neighbors.

Access

Bob "Big Foot" Battagin, 5491 Kales Ave., Oakland, CA 94618

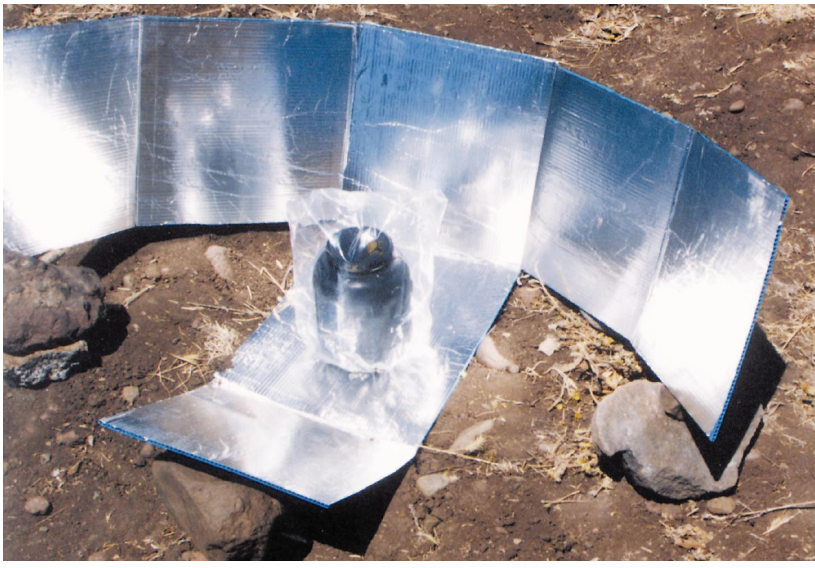
Home Power's Third Annual Solar Cooker Contest

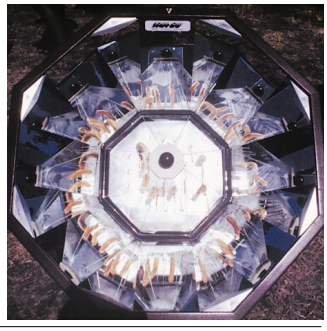
Richard Perez

Thirty brave souls attended the 100°F cook-off at Camp Creek, California on August 6, 1994. The day sizzled with sunshine and solar cooking. Five contestants cooked off for the prizes!

Home Power has been running this solar cooker design and construction contest annually for the last three years. Our objective is to promote new designs in cookers, particularly those suited to home construction. This year's contest was judged by four experienced solar cooks: Jay Campbell, Kathleen Jarschke-Schultze, Therese Peffer, and Serena Somers. Each cooker was judged by these criteria: performance, buildability, ruggedness, and beauty of design. Each cooker cooked an identical large tamale pie.

This year's solar cooker contest was won by Jeff Gilbert's parabolic cooker named the Yellow Cradle (all winning cookers are pictured on page 34). Jeff scored 971 out of a possible 1220 points to win first place. The complete construction plans for Jeff's *Yellow Cradle* follow on pages 35–37. Second place was won by Rodrigo Carpio of Ecuador, whose cardboard cooker scored 957 points. Rodrigo is an experienced solar cook and the author of an excellent solar cooker construction manual written in Spanish. Third place was won by Jim Reiman's plywood, four reflector cooker which scored 925 points. Jim's cooker scored high marks for both performance and ruggedness. Kevin Reiman, Jim's nephew, (solar cooking must run in this family) placed





Right top: Judges mark their ballots.

Right second from top: Jim Reiman and Jay Campbell discuss solar cooker construction.

Right third from top: An ultra compact and inexpensive solar cooker designed to purfiy water. This cooker boiled a quart of water in two hours.

Right bottom left: Jay Campbell who is designing the water purifying cooker shown above and promoting solar cooking worldwide. Jay came all the way from Albuquerque, New Mexico to be the Head Judge of this contest.

Right bottom left: The commerically made Solar Chef cooks a dozen hot dogs in minutes.

fourth with his plywood cooker scoring 911 points. Jim Shoemaker placed fifth (829 points) with a novel cooker made from a car tire.

While the contest cookers were cooking the official tamale pies, other solar cookers produced the rest of the feast. Mounds of food — hot dogs, BBQ ribs, dolmas, banana bread, nachos, a 14 pound turkey, apple cobbler, and fresh baked bread — appeared, all cooked in over a dozen solar cookers. Everyone sat down to solar feast!

Special thanks to Jay Campbell. Jay won our last two contests and was our head judge for this one. Jay added his years of solar cooking experience to the event, telling us of his new solar cooking projects in South America. Jay is working on a fold-up ultralight, water purification cooker designed for emergencies and refugee camps. This cooker folds up to the size of a book yet it boiled a quart of water in about two hours. The only accessories required are a few rocks, a black jar and an oven bag.

Not all the cookers present were home made however. Sam Erwin of Solar Chef brought two of his commercially made cookers. One is pictured here in hot dog mandala mode. These cookers amazed Karen and Kathleen by cooking a turkey in about three hours and a loaf of bread in about 45 minutes. Karen bought one of the Solar Chefs and Kathleen bought the other.

One of the main pleasures of solar cooking contests is the leftovers. The HP Crew reheated these goodies for days afterward, in solar ovens of course.

Access

Author: Richard Perez, c/o Home Power, PO Box 520, Ashland OR 97520 • 916-475-3179 voice or FAX. Email via the HPBBS 707-822-8640 or via Internet: richard.perez@homepower.org

First Place Contest Winner: Jeff Gilbert, 409 Christopher Avenue, Gaithersburg, MD 20879 • 301-258-0728

Second Place Winner: Sr. Rodrigo Carpio Cordero, Fundacion Inti Uma, PO Box 01-01-607, Cuenca, Ecuador, South America.

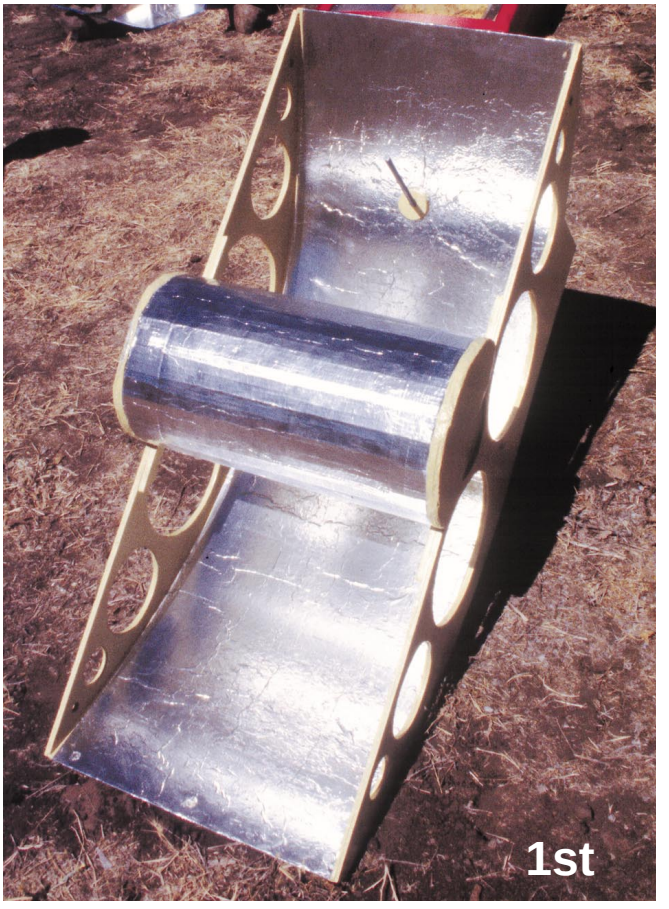
Third Place Contest Winner: Jim Reiman, 195 Gorden Way, Grants Pass, OR 97527

World-wide Solar Cooking Superhuman: Jay Campbell, Applied Engineering, 218 Dartmouth SE, Albuquerque, NM 87106 • 505-256-1261. Or Email via 73670.3236@compuserve.com

Sam Erwin, Solar Chef, 2412 Robinson Road, Grants Pass, OR 97527 • 503-471-4371

The Winning Solar Cookers

Complete plans for the winning cooker.



Above: The 1st place cooker and winner of a Solarex MSX60 PV module, the Yellow Cradle by Jeff Gilbert.

Below left: The 2nd place cooker and winner of a Solarex MSX10 Lite PV module, Rodrico Carpio Cordero.

Below right: The 3rd place cooker and winner of a Solarex MSX5 Lite PV module, Jim Reiman.

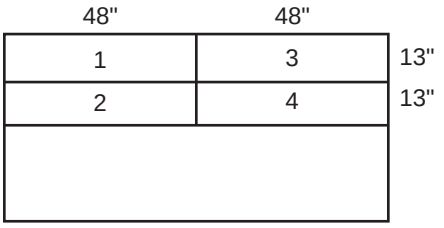
The Yellow Cradle

Jeff Gilbert

The Yellow Cradle is a simple to use solar cooking design that can be made from common material such as plywood, cardboard, aluminum foil and glass.

Steps for Construction

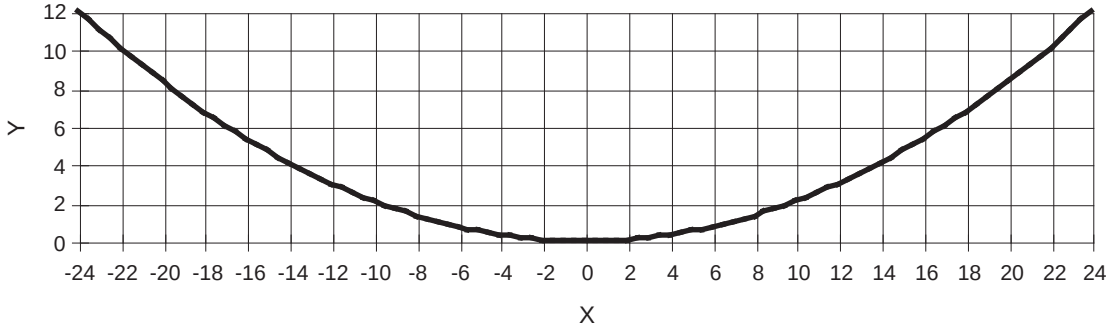
1. Mark a 4 foot x 8 foot piece of 1/4 inch plywood into four 13 inch x 48 inch sections as shown in the diagram below. Cut out these sections.



2. Draw a line across the plywood spaced every 2 inches The 24 inch line (halfway between the ends) will become the center point of the parabola (x = 0).

Example: The coordinates (±2, .08) simply means that 2 inches either side of the center point, you should measure .08 inches from one edge of the plywood and make a mark. Don't worry if you never could grasp plotting graphs in school; this is not complex.

Below:Template for the Parabolic "Yellow Crade"



The parabola used for this cooker has the formula

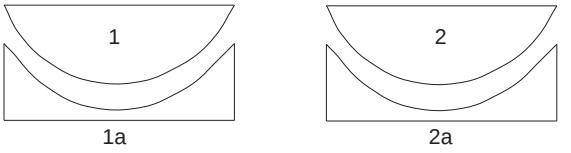
$$X^2 = 4Fy$$

where F is the height of the focus, (i.e., where the light will focus).

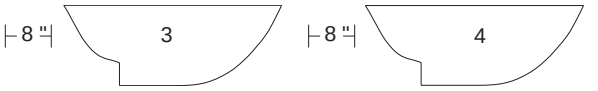
For this design, the F is at = 12 inches

3. Draw a line joining the marks which form the outline for the parabola and cut along this line. Use the first piece as a template for marking the same cut on another of the 13 inch x 48 inch plywood pieces. Cut carefully and accurately. Note: Do not cut out the 8 inch wide pieces yet (see measurements diagram on page 37 to see what is meant by the 8 inch wide piece).

Template



4. Using your template parabola, trace and cut the other two pieces of plywood according to the measurements diagram, including the 8 inch pieces. The parabola template should be positioned 1 inch down from the top edge before you begin tracing.



5. Glue piece 1a to piece 3 with the bottom edges flush to each other and the parabolas facing up (see main diagram). Repeat this step with piece 2a and piece 4. Note: Use clamps or weights to hold pieces firmly together while glue is drying.

6. Mark and cut out piece 5 from the main stock of plywood. This piece will be used to form the curved surface of the cooker.

7. Glue pieces 1a – 3, 2a – 4 and 5 together as shown in the main diagram. With pieces 1a – 3 and 2a

±X inches	Y inches
0	0.00
2	0.08
4	0.33
6	0.75
8	1.33
10	2.08
12	3.00
14	4.08
16	5.33
18	6.75
20	8.33
22	10.08
24	12.00

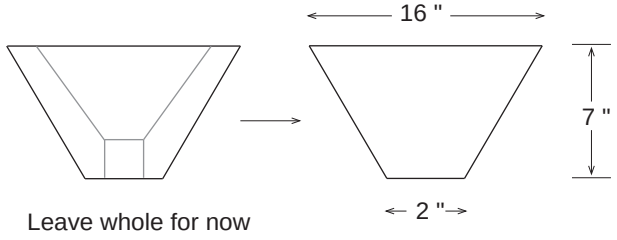
– 4 parallel and 18 inches apart, lower piece 5 between 1a – 3 and 2a – 4 so that it bends and rests on the ledges formed by 1a and 2a. Note: This step may require two or more people, however, one person can do it with some ingenuity, props and tape.

8. Glue pieces 2 and 3 in place as shown in main diagram. Be sure to push pieces 2 and 3 down firmly, sandwiching piece 5 in place.

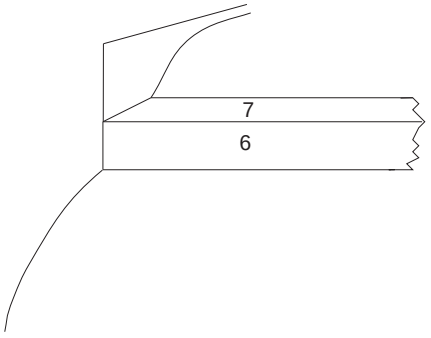
9. After glue has dried, turn the assembly over and cut pieces 1a and 2a to follow the contour of pieces 3 and 4.

10. Glue heavy duty foil onto inner surface of reflector. Note: An alternative way to secure the foil is to paint the inner surface and apply the foil while the paint is still tacky. I recommend this way because it tends to secure the foil better.

11. Mark and cut out the rest of the pieces according to the measurement diagram. See diagram below for details on pieces a, b, c, d, e and f.



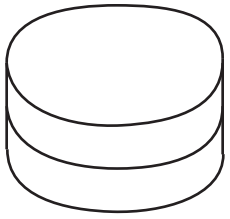
12. Glue pieces 6 and 7 into place as shown below.



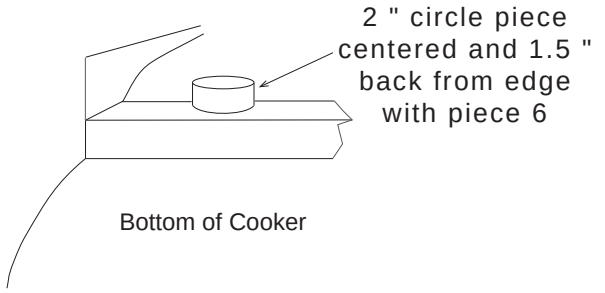
13. Glue two of the 2 inch diameter circles together to make a 2 inch circle of double thickness. Repeat this step for the other two circles.

14. Repeat step 13 for the 5 inch circles.

15. Glue three of the 3 inch x 18 inch pieces together (faces together).



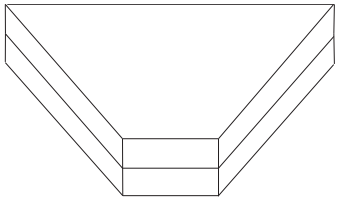
16. With reflector assembly up-side-down, glue one of the 2 inch circle pieces to piece 7 such that it is in the middle of piece 7 and centered 1.5 inches from the edge where piece 7 joins piece 6.



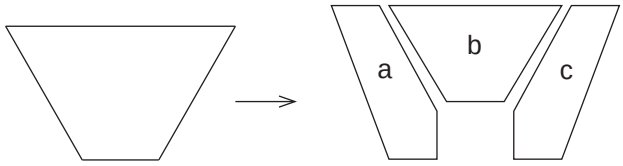
17. After glue has dried, drill a 3/8 inch hole vertically through the center of the 2 inch piece and down through the reflector surface.

18. Glue the other 2 inch circular piece over the hole that you just drilled through the reflector surface. Position the 2 inch piece high on the slope of the reflector so that when you drill through it from the other side, the bit will come through near its center. Then drill the hole all the way through.

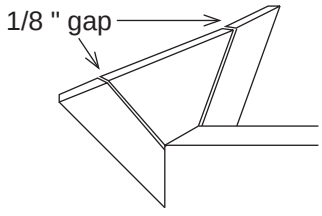
19. Glue pieces a,b,c and aa,bb,cc together. Repeat this for d,e,f and dd,ee,ff.



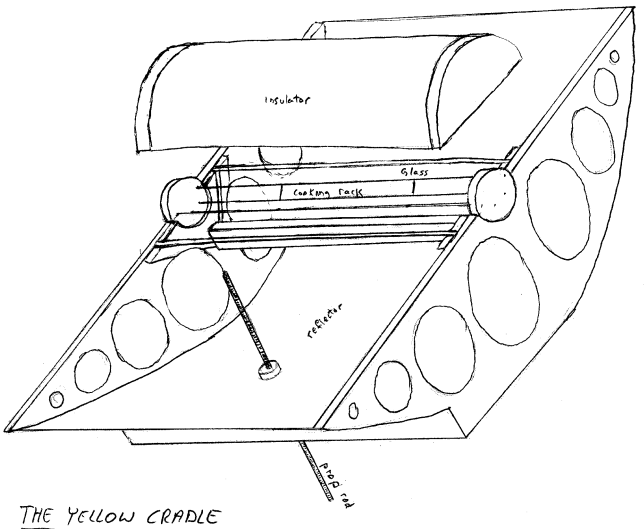
20. After the glue dries, make the cuts separating pieces a, b, c, d, e and f as well as the notch that fits piece 8. See main diagram if you get confused.



21. Glue pieces 8, a, b, c, d, e and f into place leaving a 1/8 inch gap between pieces a and b, c and b, d and e, and f and e. See diagram below.

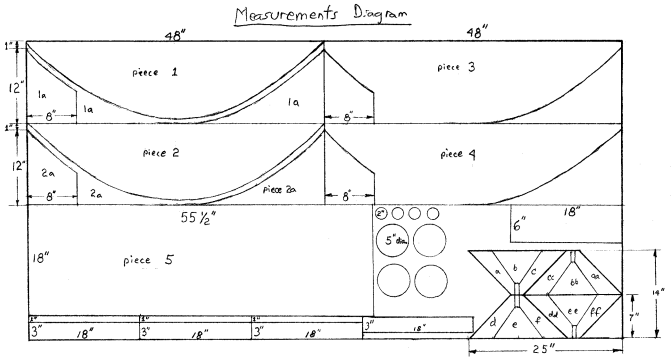


22. Drill small holes in the two 5 inch circles and insert metal rods (coat hanger wire or whatever is available) to form the cooking rack.



THE YELLOW CRADLE

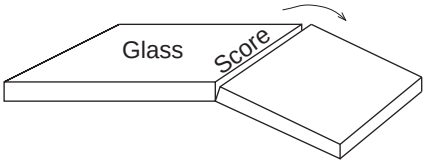
by Jeff Gilbert
409 Christopher Ave, #22
Gaithersburg MD 20879
(301) 258-0728



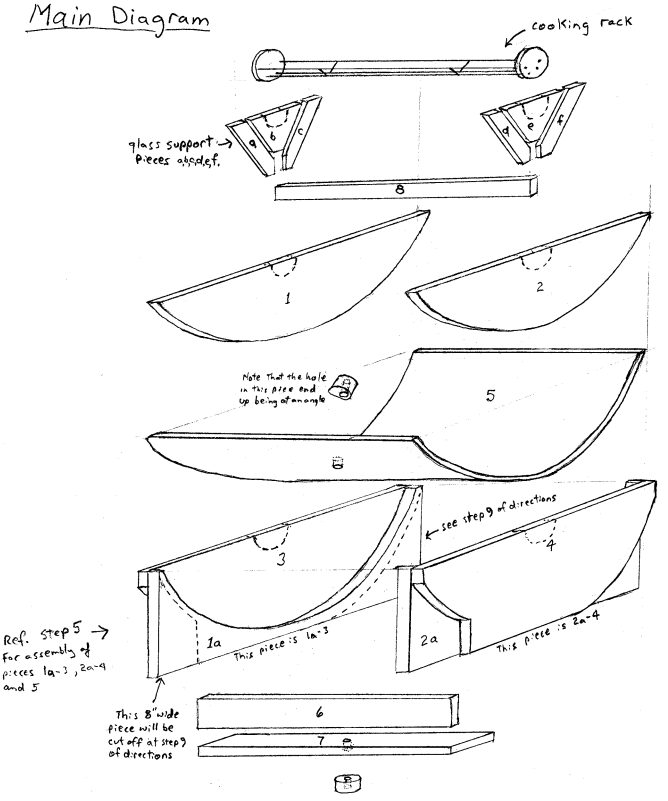
23. Fashion an insulator lid out of corrugated cardboard such that it forms an 8.5 inch diameter half cylinder that's about 1 to 1.5 inches thick and cover with foil (use glue). Bending the cardboard over a cylinder works well. This lid could also be box shaped.

24. Cut two pieces of glass to fit into the 1/8 inch slots formed by pieces a–b, c–b, d–e, and f–e. The dimensions are about 17.75 x 5.5 inch. These pieces of glass need to be tailored to avoid gaps that would diminish the performance of the cooker. Slide them into place. Cutting glass is easy, however you do need a glass cutter. All you have to do is score a straight line on the surface and break the glass along the score.

25. Cut out 5 inch half circles to fit the cooking rack.



26. The cutout circles on the sides in the main diagram are purely decorative .



Using the Yellow Cradle solar cooker

The Yellow Cradle cooker is simple to set up.

Step One: Insert a 3/8 inch threaded steel rod (or something similar) into the hole in the reflector surface. The angle of the cooker can be adjusted to track the sun by lifting or lowering the cooker on the rod. The position will become secure by pulling the foot of the rod out a bit.

Step Two: Insert cooking rack. The angle of the rack can be adjusted to keep a level cooking surface by rotating it.

Step Three: Place cooking pot on rack and place insulating lid on top.

The angle of the cooker should be adjusted every 15 minutes or so to keep maximum light focused on your pots.

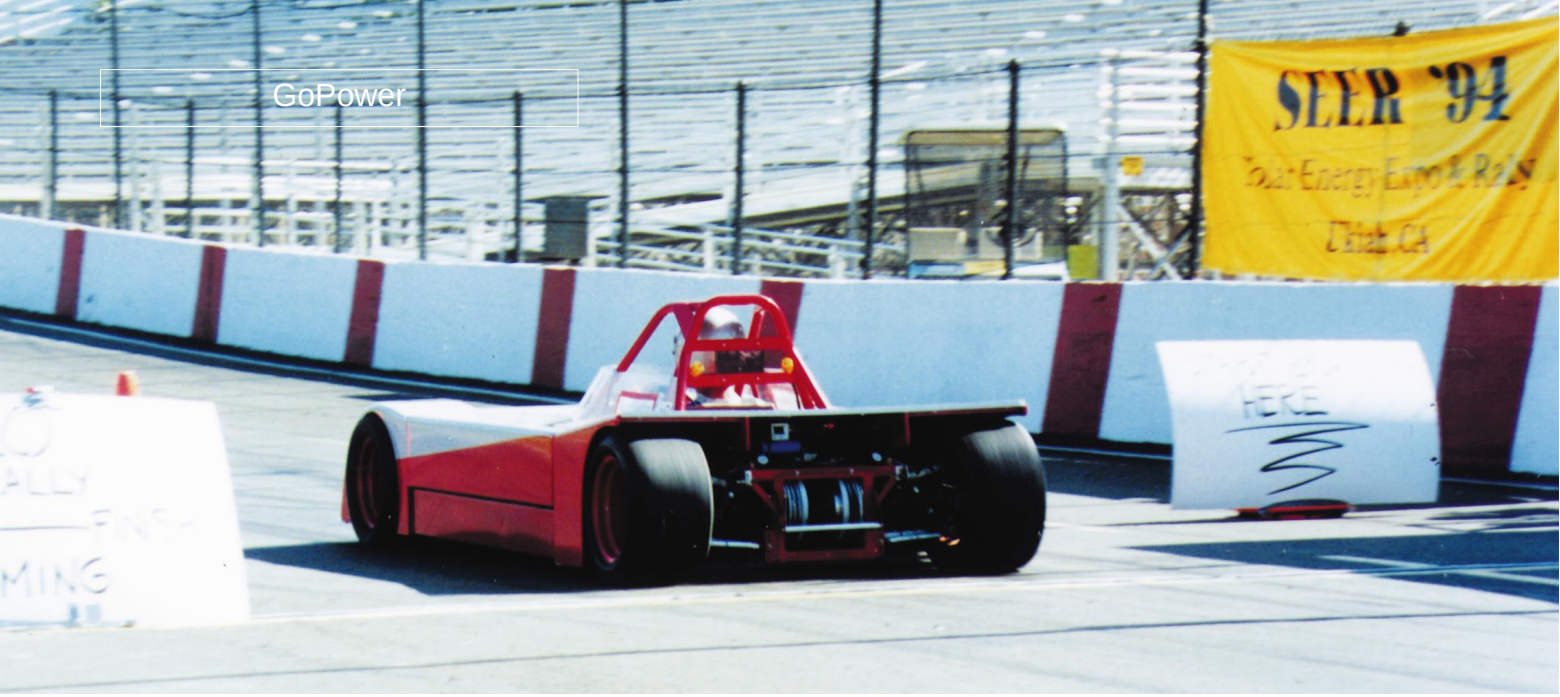
Performance: This cooker has been tested. It took one hour and forty-five minutes to boil water at sea level with a clear but hazy sky in Washington DC. The maximum temperature recorded was 260°F.

Access

Jeff Gilbert, 409 Christopher Avenue, Gaithersburg, MD 20879 • 301-258-0728

GoPower

Above: Kathleen Jarschke-Schultze takes a ride in an electric Land Rover at SEER '94 in Ukiah, California. Electric vehicles were everywhere — from an electric wheelbarrow to this totally silent 4WD conversion! Read on for more EV fun!



Above: The 200 electric horses of Snowhite get track time earlier on the day of the race.

Time Out!

Michael Hackleman

I took time out from my new book for SEER '94. It's the closest thing to a vacation Donna and I will have this year. SEER is always fun and interesting — old friends, new friends, brainstorming, pipe dreams….

Big Races

My personal thrill was announcing an impromptu, one-on-one, 5-lap race between Bob Schneeveis' Snowhite race car and a fast gasoline race car. It happened in a break between the quarter-mile, gasoline-powered races that coincided with the SEER activities in Ukiah. Initially planned to be a simple demonstration, a last-minute effort by Chris Koveleski, Jon Frey, Phil Jergenson, and a few more of us turned it into a race. A big race crowd and a whole bunch of racers watched in wonder as the two vehicles squared off, each positioned on opposite sides of the track. Bob and I got to prepare the crowd for what they were about to witness and what EVs can bring to racing (no noise, zero pollution, and competitive low-buck fun). When the green flag dropped, Barry Goldene (twice a national champion in A-modified in Autocros) punched Snowhite's twin-100 HP drive trains into motion, gaining a 2-second advantage after one lap. The race was still dead even at 4 laps, despite the gas racer's advantage in being "tuned" to the track . As the checkered flag dropped, the modified had gained a 0.2 second lead over Snowhite. The crowd roared. Sidelined drivers were notably impressed at how hard the gas machine had to work. I'll bet they're still talking in the shops all over the county!

Snowhite is an impressive piece of machinery. With ten Optima 800 lead-acid batteries (each 12 V, 50 Ampere-hours) in each saddle-pack, the pack's 240 Volts is fed to two series motors (8-inch Advanced DC motors), each belt-driven to a rear wheel. The motors are wired in *series* with Otmar Ebenhoech's "special" controller (1000 A, 250 V) holding reins on the horsepower. At 85 mph, Bob can shift into "second", re-wiring the motors in parallel with the pack voltage. Although Snowhite's never had a place to run full throttle, the 0–60 mph of 3+ seconds and 14.9 second laps at SEER suggests it'll hit 145 mph in 2nd. Bob's thinking of two new cars (Snowhite's for sale!) and an HP article is in the works.

Below: Snowhite gets a battery swap.

Little Races
SEER is a great time for Electrathon racing, since it's possible to compete three times in three days. Dann Parks has the insider's view on the races in *Electrathon SEER*, and a writeup on his prototypes in *The Lightning Series*.

Zippy Scoots
There was a gaggle of small, two-wheel, electric zippers at SEER, including several EABs (Electric Assist Bicycles). Finally, I was able to try the ZAP, a bolt-on electric assist for bicycles, as you'll discover in *Zapping the Commute*, this *GoPower* section. Green Motor Works (North Hollywood) has its own version of this basic transportation, called EROS, from Joe Stephenson. (My apologies to Bill Meurer; he's responsible for the photo of Donna and I alongside the EVX last issue.) Otmar Ebenhoech and friends brought several versions of electrified scooters (the original kind, like skateboards with soft wheels and a steering post). Simple, cute, fast, and pleasantly dangerous. Bob's Schneeveis' electric wheelbarrow (I hadn't seen it since Phoenix '92) was there. Dick Rahders brought Speedster II, and Richard and Karen Perez got a chance to drive it on the streets of Ukiah. In response to HP readers' requests for more tech-talk on Michael Leed's article on the original Speedster (HP #39), I prepared a writeup on the changes that I made on it to create *Speedster II: Street-Savvy*.

Video Release
Finally, after many years of false starts, HMV-1, the first in the *Hand Made Vehicles* series of video tapes, is ready! I've been videotaping solar and electric cars since 1988, with the intent of doing something like a video bookstore. (Order with a $22 deposit. Return it within 2 weeks, you're charged only a $7 "rental" fee. Or keep it, and it's yours! The deposit IS the purchase price.) Part documentary, part entertainment, and part instructional, the 55-minute HMV-1 covers conversions, scratchbuilts, and prototypes. There's nothing like seeing the real thing up close, meeting the people behind the machines, and discovering the factors that shaped the designs. The goal of the HMV series is inspiration and enpowerment, helping people design and build their own EV for farm, street and highway use. HMV-1 includes a 12-minute documentary, *Going Electric*, that I produced for broadcast in conjunction with CityTV. Subsequent HMV releases will focus on specific EV types (solar, HPV-EV, hybrids, conversions, prototypes, racers, aircraft, etc.).

Access
Michael Hackleman, POB 63, Ben Lomond, CA 95005.

Top: Michael Hackleman in the Sun Coaster.
Center: Richard and Karen Perez prepare to take the Speedster on Ukiah's city streets.
Bottom: The electric wheelbarrow was a definite hit — ferrying people, food and cold drinks.

Above: Rose Gunion in the Leeds Speedster.

Speedster Two: *Street Savvy*

Michael Hackleman

Following its debut at Phoenix in 1992, the Leeds Speedster (HP #39, p. 42) went through a cycle of appearances and was loaned out to Ward Phillips Company, Cal State L.A., and several schools in the San Francisco Bay Area. With a frame and suspension designed for solar racing, it was getting "thrashed" by street use and the antics of too many inexperienced drivers. Clearly, the Speedster needed a major overhaul for street use.

In the Speedster, I saw proof of the merits of electric propulsion in a lightweight vehicle. With only 72 Volts of batteries, a 4.5 HP motor and a single-ratio rear drive, the 600 pound speedster accelerated briskly from standstill to a speed of 50 mph.

While the Speedster was a delightful demonstrator, it lacked passenger space. To let someone experience it meant letting them drive it. The Speedster's quiet elegance disguised its powerful acceleration, as many a novice discovered. This is not to say that it felt dangerous to drive. I rate the overall ergonometry of the vehicle as intuitive. Still, the worn steering system made it bump-steer (change direction when it hit a bump). Designed for a racetrack, the Speedster was clearly dangerous to use on the street. It had poor driver access and no reverse gear. It also lacked a strong suspension, stable mirrors, and a roll-bar.

UpGrading the Speedster

With these problems in mind, I approached Paul Lee (the original sponsor for the Speedster) and Dick Rahders with a plan to upgrade the Speedster for a new mission in life: street safety and passenger-carrying capability. The proposal was accepted and I began work. Over the course of several months, I noted these observations and made these changes.

Rear Wheel Assembly

The MOPED rear wheel assembly was too small for so fast and heavy a vehicle. Frequent tire blowouts, a noticeable lean in turns and the easy burn-outs from standstill suggested that something stronger was

needed. I adapted a larger, huskier wheel/tire/rim from an Aurenthetic. There were two side-benefits to this change. The wider wheel could be run at lower tire pressure, softening up the otherwise unsuspended hard-riding rear end. The wheel's smaller overall diameter also decreased the drive ratio, reducing tire-spinning torque.

Front Suspension

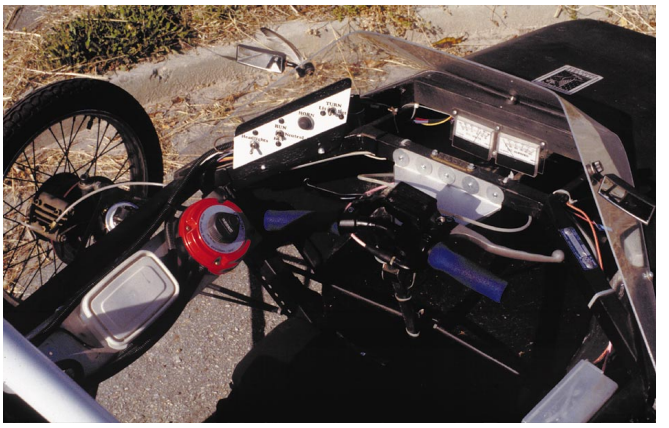
The parallel A-arms (front wheel support) were designed for solar racing and were too small for street use. The vehicle bump-steered. Increasing the wheel caster eliminated some of this. Nevertheless, front wheel alignment changed continuously with use as the undersized components bent and flexed. I installed larger front spring-shocks to relieve stress on the lighter suspension components. Previously a driver weighing over 150 pounds would completely compress the old springs.

Rear Seat

A rear seat was installed, providing a space for a passenger during educational demonstrations. The seatback was designed to pivot forward and lie flat against the seat bottom to give access to the battery charger and extension cord. This feature also improved aerodynamics when no passengers were aboard and increased cargo capacity.

Battery Pack

The six 24 C3 batteries in the battery pack were worn out. These were replaced with more robust 27TMH Trojan batteries and divided into two saddle-packs. Mounted on (and secured to) extensions off the frame



Above: The controls and instruments are within easy view and reach of the Speedster's driver.

on either side, this arrangement created rear passenger space. A plastic cover, removable for maintenance, was installed over each pack to prevent curious fingers from touching battery terminals.

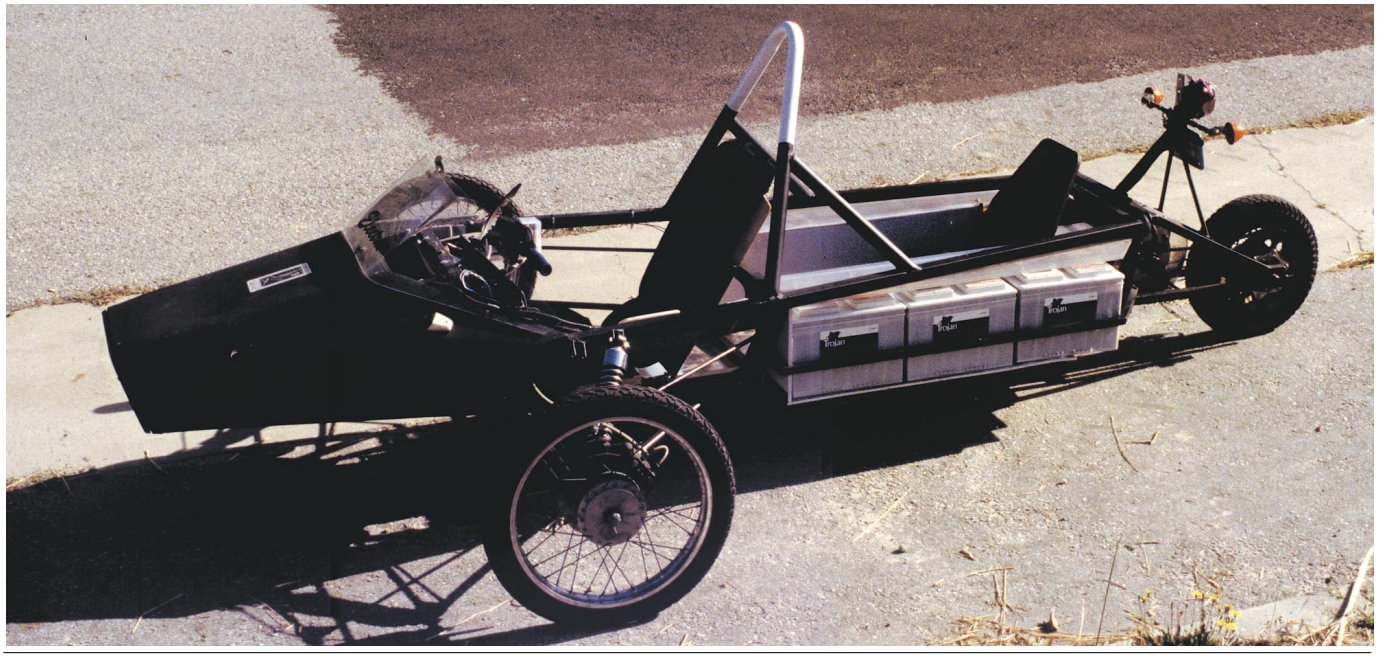
Steering Support

The upper steering post support, weakened and sloppy from overloading, was replaced and structurally re-enforced. A rod lock was installed on the lower steering support to keep the arm from popping out (as it did occasionally, turning a casual cruise into an adventure).

Control Panel

The run, horn, headlight and turn-signal switches, originally mounted on the steering post's upper support, were re-mounted on an aluminum panel. This

Below: The finished Speedster Two waits for a driver and passenger at the curb.



Above: Brett Hackleman eagerly awaits his driver's license to go electric.

panel was located within easy reach of the driver and positioned for maximum visibility. A reversing switch was added, all switches got labels, and indicator lights were added for night driving.

Emergency brake
An emergency brake, adapted from a Datsun 280ZX, was installed and connected to the rear wheel brake assembly.

Roll Bar
A roll bar, fashioned from 2-inch muffler tubing, was added to the vehicle. (Stronger tubing is called for.)

Reversing Circuit
Reverse "gear" was added by modifying the electric drive train. I took a low-budget approach, using four 12 Volt starter contactors, to reverse the field winding relative to the armature. This is essentially a double-pole, double-throw operation. (Another mistake. This was less safe and reliable, and more time-consuming than just buying a $175 reversing contactor.)

Miscellaneous
The upgrade involved extensive detail work. The vehicle was rewired, and many components re-located. I recessed and shock-mounted the headlight assembly to avoid the frequent damage it sustained when the vehicle's front end encountered something. The turn-signals and brake light were made operational. I installed motorcycle tires on the front wheels. The front seat was re-designed for better driver access and increased back support. The charger was installed onboard. The hydraulic brake cylinder was overhauled, the brake system bled (the fluid looked very funny) and the disc brakes adjusted. Once I re-wired the Speedster, I drew up a complete wiring diagram from my sketches and drafted a system schematic. These will aid mechanics or electrical technicians in troubleshooting and repair.

Operations Manual
I also put together an Operator's manual for the Speedster. It lists and describes all vehicle components; their function, location, and operation. Besides helping the novice operator to understand vehicle features, this manual gives appropriate warnings about maximum vehicle speed, loading and other operational limits.

Registration, License and Insurance
The Speedster is street and highway legal in California. Because it is a three-wheeler, it falls into the general classification of a motorcycle. (This new class is bigger and more powerful than a motorized bicycle.) As with any motorcycle, comprehensive or collision coverage is expensive, unless your policy has a high deductible. A relatively inexpensive insurance rate provides good liability coverage. The one disadvantage to the Speedster's motorcycle classification is the requirement for wearing a helmet. The roll bar and seat belt would probably offset the lack of a helmet, but this has not been tested. The only consolation here is that, even with the helmet, it is easy to hear what's going on around you since there is no engine noise.

The Next Step
The Leeds' Speedster is a proof-of-concept vehicle, and a good first version of a street machine in the 800 pound (running weight) class. The existing vehicle's construction is too compromised to allow further improvement without major structural changes in the frame. To create an exact duplicate of this vehicle would cost $4,000 in parts and $4,000 in labor.

What's the next step in its evolution?
This is what I see:

1. Design for a 1200-lb running weight with driver (175 lbs). Add passenger weight. Increase the pack voltage to 120 Volts. The ten 27TMH series batteries weigh 600 lbs, requiring a maximum body and frame weight of 425 lbs to stay within design limits.

2. Fit an all-weather, aerodynamic shell. The canopy-roof should remove for touring. Integrate a roll-bar into the rear bulkhead support. A high-bottom door on one side will give a sporty access without compromising overall lightweight structural support.

3. Position the driver and passenger in a tandem-offset seating arrangement *above* the battery pack, ensuring

good visibility for the driver. The high profile helps other drivers to see this vehicle, and locates the battery weight low, center, and forward for stability. The "stacked" arrangement minimizes vehicle width and length.

4. Add an exchangeable battery pack. It can be split into two identical, 300 pound "modules" of 60 Volts each. These may be saddle-packs or lay side-by-side across the width of the vehicle.

5. Upgrade the propulsion package to a 10 hp series motor and PMC controller. A 4:1 (fixed) gear belt drive will give a 60 mph top speed while ensuring good low speed performance. Include electric reverse and regen braking.

6. Arrange the vehicle as a standard 4-wheeler or as a motorbike (3-wheel). In the 4-wheel configuration, the FRW (front-to-rear weight) ratio is 1:1, with the rear wheels driven through a Comet differential. In the 3-wheel layout, the two front wheels are both steered and powered, and the FRW ratio is 4:1 for good stability. With this light a vehicle, the rear wheel of a three wheeler supports too little weight for traction during acceleration or regen braking.

Access
Michael Hackleman, POB 63, Ben Lomond, CA 95005

Everybody checks their mailing label, Yes everybody!

The last issue of your subscription is printed in plain English on your mailing label. Don't let your sub expire!

Karadea Solar Training Facility
PO Box 299
Karagwe, Tanzania
Africa

22 June 1994

Dear Home Power,

Here is a photo of our students checking their Home Power mailing labels.

It may be hard for you to imagine, but we are scarcely 100 km from the Rwanda border. The students helped carry out an ad hock repair on an operating theater solar system which serves one of the refugee camps.

We anticipate holding further trainings in November this year, and in spring next year. If any readers desire information about our programs, please contact us.

If any HP readers or advertisers are interested in donating demonstration and class room equipment, we could make good use of it here. We are particularly interested in PV stuff, wind generators, solar cookers and water heaters. As well, we have facilities here for self-supporting volunteers interested in doing educational and demonstration projects.

Best Wishes, Frank Jackson and Gaspar V Makale

Above: The ZAP electric power pack for a bicycle.

Zapping the Commute

Michael Hackleman

Want a non-polluting commute? Something a bit more than the reliable, lightweight bicycle? Are you ready for 20 miles of electric-assist for your bicycle at 4 cents worth of electricity? Check out the ZAP.

The ZAP Power System is the result of a three-year project by Jim McGreen to design a practical, non-polluting power source for a bicycle that helps with hills and headwinds. The result is the ZAP (Zero Air Pollution) bike kit. It's a bolt-in electric propulsion system that installs in an hour. A ZAP-equipped bike is a true human/electric hybrid; clean, silent, and efficient.

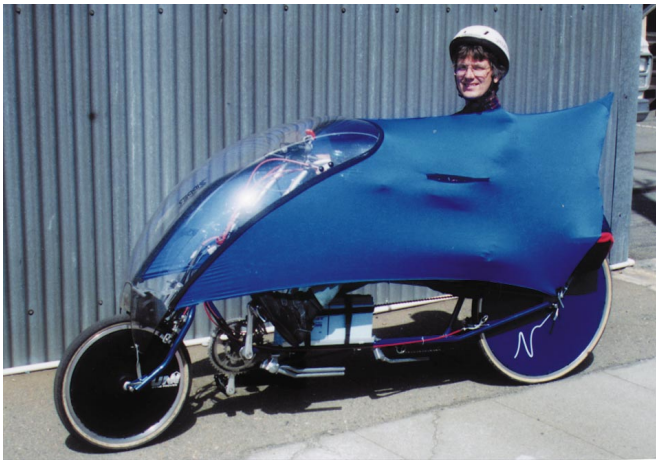
I first saw a ZAP'ed bicycle in Hawaii during the Pali Challenge. One of the first vehicles to head out, it was back quickly, the bike's champion rider ready to quit. A few of us gathered around it, wondering what was wrong. We quickly saw the problem, re-adjusted the drive roller tension and convinced the rider to try again. Ten minutes later, I rode with the race staff toward the first check point. We found the ZAP entrant partway up the hill. I rolled down a window as we slowed to match his pace, ready to ask him how it was going. He had a big smile, a cheerful reply and gave us a thumbs-up. He was definitely climbing that hill faster than any pedal-only bike I had ever seen!

Several bicycles using the ZAP Power System were at SEER 94. Since my booth stood nearby, I zipped over between crowds to test-drive a ZAP. The vehicle is intuitive to use. This ZAP used a rear wheel drive (the Hawaii one was mounted on the front). Even though I couldn't test the "unique torque-sensing mount for best traction and efficiency", the ZAP did everything I asked of it.

To accommodate a variety of bicycles and trikes, McGreen has made the ZAP available in four configurations: single and dual motors for bicycles and trikes. The kits are meant to supplement leg power, not replace it. The Single 500-watt motor supposedly gets the bicycle to 15 mph without pedaling, and the Dual I used easily reached the advertised 20 mph speed. ZAPs are also made for trikes, use a high-torque, 350-watt motor, and claim a Single will reach 8 mph and a Dual 12 mph. Speed ranges increase when you pedal and decrease on hills.

Sealed lead-acid gel-cells make up the ZAP's battery pack. Two sizes are available. The smaller one (17 aH) will take a bicycle 10 miles on battery alone (dual system, 1st speed range). The larger pack (33 aH) will push this range to 20 miles. Expect the small pack to give you an hour of pedal-assisted transportation, while the larger pack will give you two hours. With proper care, the batteries should deliver 400-1200 cycles.

The ZAP is recharged from stationary or onboard units, or a solar panel. The single-motor drive uses a simple one-speed controller; ON for go, OFF for coast. Downhill and ON provides regenerative braking. Motor, controller and mounting hardware weigh in at 5 lbs (w/out battery) and are adequate for flat terrain. The Dual-motor setup I tested uses a simple 3-speed

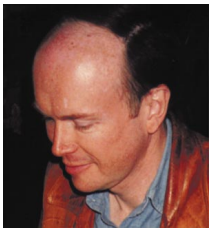


Above: Mike Saari and the ZAP dual drive power pack.

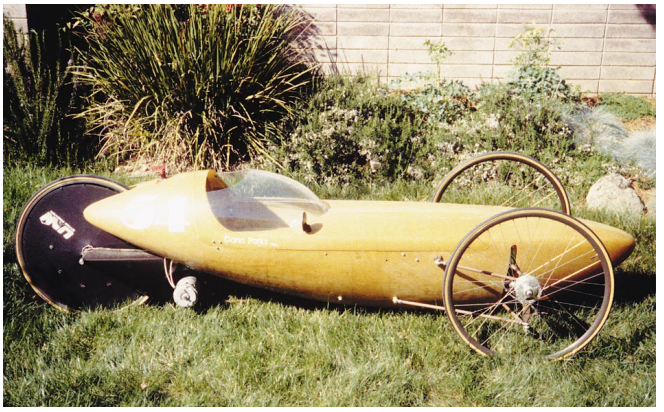
controller (non-pedal 11/16/20 mph), weighs 8 lbs, and is recommended for hillclimbing and high-speed operation.

What does it cost? For the bicycle, Single ($299) and Dual ($399). For the trike, Single ($315) and Dual ($425). You'll want to buy the 17 aH ($62) or the 33 aH ($71) batteries locally to save shipping costs. Options include: 55-watt halogen headlight ($35), stationary 10-amp charger ($68), onboard 4-amp charger ($60), and solar panel (AOR). Whether you bike for fitness, overall mobility or to enjoy the outdoors, get ZAP'ed at the first opportunity.

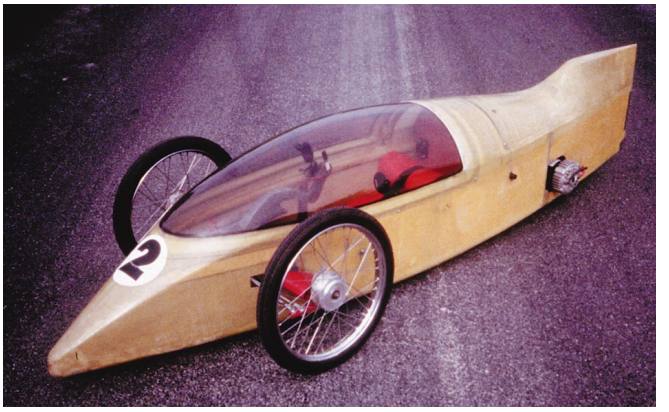
Access
McGreen Development, PO Box 1217, Alameda, CA 94501 • 510-523-8103



Silent Drive
Paul Brasch, an EV pioneer and advocate, and creator of the Electric Auto Association's publication Current Events, died on August 13,1994. Paul was a six time president of the founding Silicon Valley chapter of the EAA (22 year member), a former member of its national board of directors, and the winner of the Keith Crook Electric Vehicle Technical Achievement Award at Wescon '93. With a 29 year background in the electronics industry, Paul was the designer of and sole source of the Precision DC Energy Monitor from Brasch Laboratories. (Paul's father informs us that the Monitor is not available, at this time, please no orders.) An article submitted by Paul to HP, Electric Cars: Toys or Reality will be published in an upcoming issue. We will miss Paul's perceptions, dedication and bright spirit. — Michael Hackleman



Above: Lightning I's (#54) clean shape and one-piece carbon-fiber drivetrain was a big hit when it first appeared in Electrathon races.



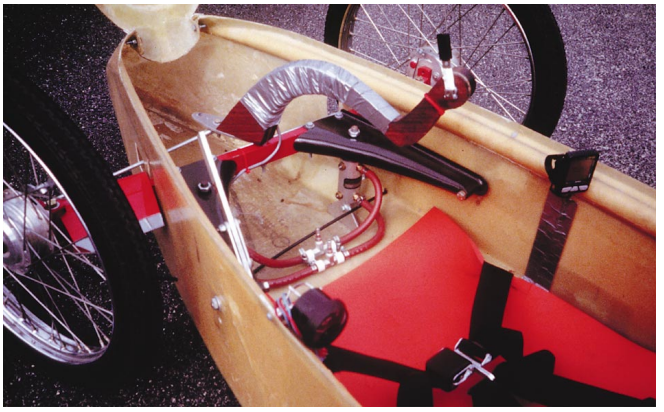
Above: Lightning II features an ultra-aerodynamic monocoque chassis/body and heavy-duty MOPED tires and brakes.

The Lightning Series

Dann Parks

I have been designing and building vehicles for almost 20 years, including working on the VORTEX with Steve Pombo. Electrathon sounded like a fun way to learn about electric vehicles and experiment with lightweight construction.

Below: Lightning II's front suspension consists of carbon-fiber leading links to a solid front axle suspended on pressure-adjustable air cylinders. Tiller steering uses a trigger speed control.

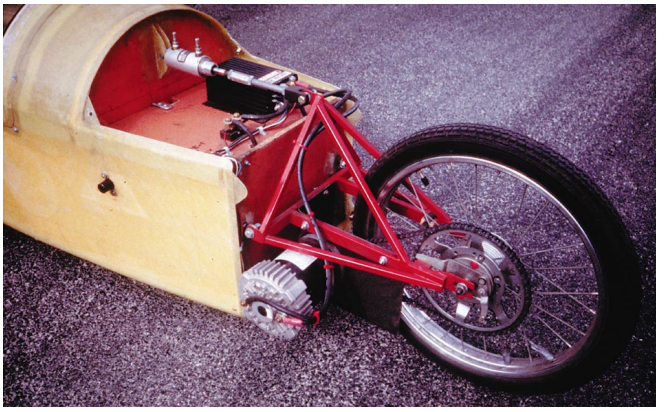


LIGHTNING I

For my first Electrathon vehicle I wanted to investigate some new materials and techniques. The Vortex had been constructed of urethane foam, fiberglass and polyester resin. I found that the foam dust and resin irritated my skin. An Electrathon vehicle, with its small size, offered a good chance to try some of the new, less irritating epoxy resins and Styrofoam, as well as the more expensive Kevlar and carbon fiber fabrics.

To minimize rolling resistance, I chose 27" bicycle wheels. Bike tires cannot withstand excessive side-loading, so I initially designed the vehicle to lean into corners. This employed a simple arrangement of air cylinders and required that the driver balance the vehicle. Electrathon rule changes (which I agreed with) later outlawed this type of vehicle. That was just as well, since during operation, my design suffered from

Below: Lightning II's tailcone is removable to expose the drivetrain. A mono-shock rear swing arm gives the vehicle a rear suspension and supports the motor and chain drive. A PMC motor controller is mounted atop the insulated battery box.



friction in the cylinders. I could continue using this vehicle by adjusting the air cylinders to lock it in the upright position. I also put heavy-duty spokes on the wheels, figuring that side-loading would only be a problem on tight courses. On the banked velodrome track, I expected the vehicle would do 30-34 mph without problems. At the time, the one-hour record was only 28 miles.

Number 54 (Lightning I) is best described as a motorbike (two steered wheels in front) with a monocoque chassis and 3-wheel suspension. The body's teardrop shape complemented the leaning concept, lifting it high in turns to clear the ground. Even as an upright vehicle, #54's body has low drag because it is aerodynamic and rides above turbulence caused by "ground effect". Positioning the batteries between the driver's legs allowed the rear of the body to taper, improving its aerodynamics. Besides keeping the body narrow, locating batteries in front shifted the vehicle's center of gravity forward.

The chassis was made entirely of Kevlar and fiberglass, using a moldless composite construction technique pioneered by Burt Rutan of Voyager fame. This is an easy way to build strong, complex shapes.

The process was straightforward. First, I carved male plugs out of Styrofoam for the left and right side of the vehicle. This is an easy-to-shape and non-irritating foam used in building insulation. Next, the plugs were covered with the Kevlar and fiberglass, and wet out with epoxy resin. After the resin cured, most of the foam was removed from the inside, leaving a strong shell. Finally, the remaining foam inside was structurally reinforced with glass cloth and resin in critical areas. This "sandwich" of glass-foam-glass is extremely strong, especially in compound curves. I used an aerospace honeycomb material (available at aircraft surplus outlets) to integrate three bulkheads into the chassis. High-grade marine plywood could be substituted. The bulkheads provided additional strength as well as mounting points for the suspension.

The front suspension was an A-arm design. Each arm shared a pivot point at the vehicle's centerline. The design originally allowed for the 12" inches of suspension travel needed to lean the vehicle. Interconnected air cylinders made one wheel rise while the other dropped an equal distance. After the rules changed, the interconnect between the cylinders was removed, locking the vehicle upright. Adjusting air pressure in the cylinders adjusted the "ride".

The heart of #54's rear end was a single-sided swing arm that combined rear wheel, motor and suspension in one assembly. This swing-arm was built of carbon fiber and Styrofoam, the same composite construction technique used on the chassis. It is very strong. The suspension was leveraged by a pull-rod forward to an air cylinder. The rigid, one-piece rear drivetrain simplified the overall design and eliminated alignment problems. I used a V-belt to drive a belt "ring" attached to the spokes. This system was lightweight, quiet, and had minimal slip.

A joystick positioned between my knees provides steering and braking. I steer with my right hand while the left manipulated the throttle lever (speed control was implemented with a Curtis PMC potbox and controller). The vehicle uses two 22NFD batteries and a Bosch motor. It weighs 80 lb without batteries. In race-ready condition, with the driver ballasted to 180 pounds, it is 324 lb.

Number 54 has been quite successful. The suspension is excellent and can be adjusted to provide a soft ride on any track. The vehicle reaches 38 mph at 40 amps on the flat. High-speed cornering remains a problem, even on the banked velodrome. It wears the tires quickly and overstresses the spokes. The small drum brakes are just adequate. #54's best run is 32.7 miles at the San Jose Velodrome.

LIGHTNING II

I wanted my next vehicle to be more robust and capable of high-speed cornering. Where Lightning I was gossamer, Lightning II would be a tank. A lightweight tank. For it, I wanted a drive-train and suspension design that could eventually be used in a lightweight street vehicle.

The wheels were the most difficult part. Bicycle wheels, even 20" plastic rims, were too light to handle side-loading at Electrathon race speeds. The cost of replacing worn tires ($75 per race) was excessive. Then I discovered and purchased a cache of moped wheels from a local garage. These rims are robust and have large alloy-drum brakes. I could modify them to fit a 1/2 inch axle and mount tires at $39 per set that could last the whole season. They also appeared perfect for a lightweight street tire.

I opted to use the Doran/Scott motor, which seemed more rugged than the Bosch. The Doran/Scott uses a standard keyed shaft. The Bosch has a weird, threaded shaft that requires the fabrication of a sprocket. I decided on chain-drive this time, for two reasons. First, the moped rear wheel already had a sprocket. Second, #54's V-belt was slipping a bit. Other design goals included keeping the bodyshell small, minimizing parasitic drag (by enclosing mirrors, axles, etc.), and using Lightning I's air cylinder suspension.

Lightning II is an all monocoque chassis/body made of Styrofoam, fiberglass and epoxy resin. I reused composite construction, but eliminated Kevlar due to difficulties in working with it. The body has a long, tapered tail to eliminate rear drag by smoothing trailing airflow. For safety, batteries were relocated from the cockpit to a rear compartment so that a bulkhead protects the driver. They are easily accessible. The rear suspension is a tubular metal swing arm containing a mount for the motor. The swing arm is leveraged by a push-rod to an air cylinder.

The front end has a solid front axle suspended from the chassis with two air cylinders. The axle pivots on two carbon fiber leading-links mounted to each side of the chassis and a tiller is used to steer. Pushing right makes the vehicle turn left (it sounds more confusing than it is). The right hand pulls the brake lever and the throttle is a pistol trigger on the tiller. It turns the rheostat of a disassembled PMC controller potbox.

I deemed good ergonomics and maintainability important for this vehicle. Consequently, the entire canopy (from an Aerocoupe) pivots upward for easy access to the cockpit and front suspension. The tail section is a light fiberglass cover that removes to service the motor, batteries, chain and suspension cylinder. Gages include an ammeter and a bicycle speedometer/timer.

Everything works exceptionally well. The tires have proven to be just what I wanted: bulletproof and long-wearing. The suspension is just as sensitive as that of the first vehicle, only more robust. I'm still dialing in the gearing. More races will determine how competitive the vehicle will be. Still, it appears to be a front-runner. Most importantly, the chassis design has proven itself worthy for street applications. That's where I want to go next.

SPARC

My next vehicle will be a neighborhood electric vehicle (NEV). I define this class as a small lightweight runabout for personal transport and utility use. It is *not* a small car. My vehicle will be called SPARC, for Single PAssenger Rechargeable Commuter. It will qualify under the California Motor Vehicle Code as a motorized bicycle — 2 or 3 wheels, top speed 30 mph, automatic transmission (if electric), and no pedals required. I plan to start on SPARC in the fall of '94.

Access

Dann Parks, 764 Devonshire Way, Sunnyvale, CA 94087 • 408-733-2539

Electric Vehicle Wiring: Part Two

Shari Prange

Several tricks are useful when measuring out wire. It's easy enough on short runs to simply feed the wire from source to destination along its intended path and then cut it, leaving a little extra for slack and connections.

Measuring Long Wire Runs

However, this is not so easy on long runs. Few things are as frustrating as cutting a ten-foot length of wire and discovering (after threading it through the car!) that it is six inches too short.

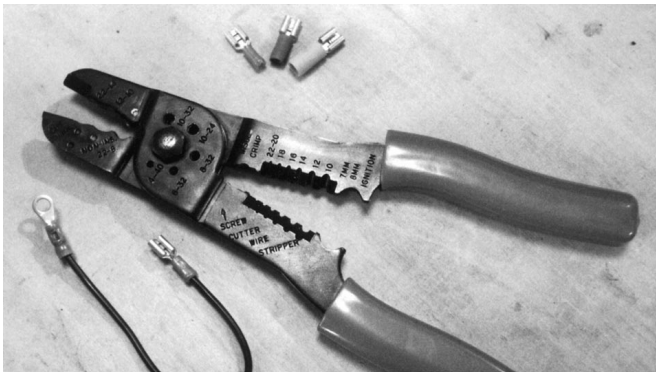
When you are running wires from one end of the car to the other, measure out 1 1/2 times the car's length. This will give you enough to compensate for all the ups, downs, twists, and turns the wire takes along the way. You will have extra, but you won't come up short. Cut off the extra wire. Put it in your scrap wire box to use later when you only need a short piece.

This technique is not practical with expensive 2/0 cable. Instead, buy a piece of rope as a stand-in for the cable. It should be the same diameter as the cable and 1 1/2 times the car's length.

Feed the rope along the same path the cable will take. When you reach the destination, mark the rope with a labelled piece of tape. You can use the same rope to measure all your cable runs. When you actually cut the cable, add six inches to the length you measured with the rope. This provides a little slack.

Small-Gauge Connections

Solid connections are vital to the success of your conversion. Loose connections will cause worse things than non-operation, namely increased resistance, which causes heat, which causes fire. Fire causes great unhappiness and embarrassment.



Above: Be sure to use good quality crimping tools and connectors.

A good connection is NOT measured by the amount of electrical tape covering two stripped wires that have been twisted together. Use good quality connectors with nylon insulation that is less likely to crack. Use a good quality crimping tool. A cheap one will loosen at the hinge pin and give a poor crimp.

Be sure to use the right connector size for your wire. They are color-coded: red for 22 - 18 gauge wire, blue for 16 - 14 gauge, and yellow for 12 - 10.

To crimp on a connector, strip the insulation back about 1/4 inch from the end of the wire. Be careful not to cut the wire itself. (A good crimping tool will have calibrated stripping notches for different wire sizes.) If you don't strip enough insulation, you won't get a good crimp. If you strip too much, you will leave bare wire exposed outside the connector, making your wiring vulnerable to shorts.

When you slide the wire into the connector, be sure to crimp the metal barrel of the connector, not just the insulating sleeve. Squeeze first with the flat jaws of the crimper, then with the crimping stud. Finally, give the finished crimp a good hard tug to test it.

Don't solder crimped connections. Soldering is messy and dangerous. A poorly soldered connection is worse than one that is not soldered at all. Solder wicks up the wire and makes strands near the connector stiff and brittle; subject to internal breakage which creates resistance. Crimp-on connectors are known as "solderless connectors" for a good reason; they don't need solder. When properly crimped, they work well.

Crimping Lugs To Cable

The same philosophy applies to cable, only more so. Soldering 2/0 cable is an invitation to third degree burns. Without industrial equipment, it is almost impossible to heat the lug and copper evenly to get a good solder joint. A "cold" joint will not conduct well. Cable also suffers from the same wicking and embrittlement problem as small-gauge wire.

Above: Crimping a lug onto a cable using a proper crimping tool.

Again, be sure to use a good crimping tool. One version looks like an enormous pair of vise-grips. It can also double as a serious body-building device, especially when crimping more than thirty connections at a time!

Another type of cable crimper is a small punch-and-cradle device used with a hammer. The lug is inserted into the cradle, which holds it in the proper position. Then you hammer on the punch, which is held in position in a sleeve. There are calibrations on the punch to let you know when the crimp is complete.

Before crimping the lug, fill the cavity with an anti-oxidizing compound such as Noalox or Cual-Aid to prevent internal corrosion. After crimping, cover the cable/lug joint with a short piece of heat-shrink tube to seal out dirt and moisture.

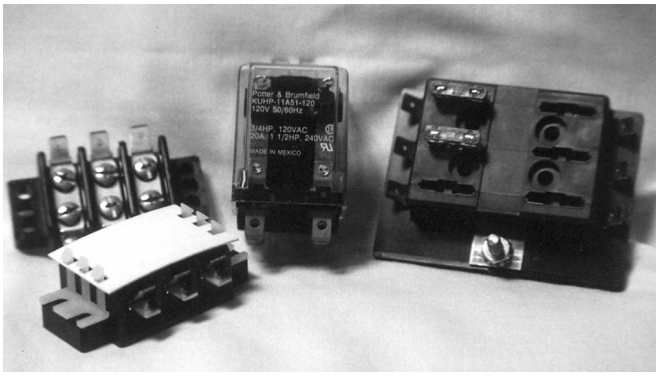
With short cables it is especially important to orient the lugs properly. To do this, crimp on one lug, then install the cable loosely in its final position in the car. Put the other lug on (don't crimp it yet) and find the best orientation for that connection. Mark the cable, remove it from the car and finish crimping.

Extra Wires

Whenever you run wires from the front of the car to the rear, add two to four extra wires to the bundle as spares. Label them as such in your notes. Someday you may want to add another component or modify the car. If you have planned ahead, spare wires will be ready and waiting for you, neatly tucked into the original loom.

Grounding

Once you could get a good ground by simply punching a hole in the chassis and attaching a wire with a sheet-metal screw. With the new paint systems, however, this is no longer true, so beware. A poor ground connection is a common cause of electrical failures.



Above: Terminal blocks, a charger interlock relay, and an automotive style fuse block.

When possible, use the factory ground points as designated in the shop manual for your model of car. If there is no convenient ground, punch a hole in the sheet metal. You must scrape or sand the paint down to bare metal to get a good connection. After you have installed your ground, cover the bare metal with touch-up paint or some other sealant.

Do not ground the high-voltage system to the chassis at any point. Batteries and all components in the high-voltage circuit should be connected in a closed loop that remains isolated, or "floating". This is necessary for the safety of both humans and low-voltage components. Many components (especially chargers) have built-in safety features that prevent them from operating if there is a ground fault to the chassis.

Fuses

The easiest and best way to power your low-voltage accessories is via a terminal block. One incoming power lead can easily supply numerous components and each connection is secure, yet easily removed. For low-voltage components that do not have built-in fuses, use a fused terminal block.

Protect your high-voltage system by inserting a fusible link between two batteries in the middle of the circuit. This fuse will melt and open quickly if there is a dead short across the battery pack. If your pack is split, use a fusible link in each section.

Every car should also have a DC—repeat, DC, not AC—circuit breaker in the high-voltage circuit. It should be within easy reach of the driver as an emergency disconnect.

Relays

A relay is an electrically operated switch. Voltage applied to a magnetic coil opens or closes a set of contacts. It is handy when you want one circuit automatically activated (or disconnected) whenever something else turns on or off. Relays are very useful in electric cars.

Relays can be “normally open” and close when power is applied, or “normally closed” and open under power. They can be activated with AC or DC and will be labelled. They are also rated for the amount of voltage and current they can carry. Be sure you are getting the right relay for the job.

Relay Applications

1. A relay can be used as a charger safety interlock. A single relay can serve a dual function by turning on a battery ventilating fan and disconnecting the ignition key circuit whenever the charger is plugged in. This evacuates any hydrogen gas generated during charging. It also prevents anyone from trying to drive the car away while it still plugged in.

2. A relay can act as a safety feature in conjunction with a PMC controller to prevent a control system failure from endangering the car or driver. The PMC potbox includes a microswitch that acts as a deadman’s switch. It is usually connected in such a way that releasing the throttle pedal opens the main contactor and cuts off power to the controller and the motor. It also disables power to the PMC’s logic circuit.

This redundancy is advisable because a control system failure in a full-on mode, while unlikely, would be dangerous. Relays can easily implement this safety feature without interrupting the operation of other components, such as a voltmeter or DC/DC converter, as long as the ignition key is on.

3. You can use a relay whenever you re-use an original wire for a new, higher-current application. Rather than overloading the wire or replacing it with a heavier gauge, you can make it activate a low-current relay. The relay’s contacts then remotely switch a higher-current circuit that uses larger wire.

Quality Shows

You can build a car that violates almost every principle of good wiring and it may still run —for a while. Sooner or later, it will fail. At best, the failure will be inconvenient or embarrassing. At worst, catastrophic. Even while such a car will operate, it will look sloppy and unsafe under the hood.

It just makes sense to do it right from the beginning. Create a car that you feel proud to show and confident to drive.

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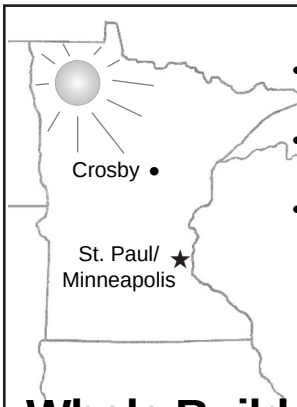

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SEER '94 Electrathon

Dann Parks

July 15–17 saw a return of Electrathon Competition to the SEER (Solar Energy Expo & Rally) event in Ukiah, California. The series consisted of three races at noon on Friday, Saturday and Sunday. Ukiah was in the midst of a heat wave, with 105 degree temperatures at race times.

A total of nine vehicles participated, coming from as far away as Los Angeles, Seattle, and New England! Team New England's entry was a modified solar car (using a Solectria AC drive!). Unfortunately, the vehicle was 4 inches too wide, but was allowed to run for no points or prize money. Gary Raymond's streamlined entry enclosed the tires inside the body. Jim McClain (normally the instructor) piloted the Citrus College Car.

The Ukiah Speedway track is an ideal track for Electrathon racing. It is a quarter (1/4) mile oval, banked 10 degrees. It's an excellent venue, with a shaded grandstand and concessions available at the site. The surface was rough and hot, so tire wear was on everyone's mind. Multiple-day Electrathon events are especially exciting. It gives competitors a chance to experiment with different gearing and driving techniques in subsequent days, and perhaps improve lap distances.

Day One: Friday

I got the jump on everybody on Friday, and set an ambitious pace in Lightning #2 . Rick Doran, driving Cloudcar #40 (builder Dave Cloud) was glued to my tail. Rick passed me 45 minutes into the race, and went on to win with 137 laps. Mark Murphy's redesigned Aerocoupe showed a strong third, with Clark Beasley (who won the race in '92 with 130 laps) logging 124 laps. Kim Alt in #111 (the land kayak designed by Bob Schneevies) blew one of her two rear tires (it's actually a four-wheel vehicle) 38 minutes into the race. The other one blew on the white flag lap, but she grabbed an impressive 117 laps for 5th place. Tire interference and a stuck brake were Gary Raymond's first day woes. Jim McClain lost a pinion gear key 8 laps into the race, and watched the rest of the race in the shade with a cold drink.

Day Two: Saturday

On Saturday, Rick in Cloudcar #40 took the lead in the first lap and never looked back, racking up an astounding 142 laps. This is a new track lap record. It also appeared to be a new distance record, but a

SEER '94 ELECTRATHON RESULTS

Pos.	Driver	Veh.	Laps
	FRIDAY		
1	Rick Doran	40	137
2	Dann Parks	2	135
3	Mark Murphy	9	132
4	Clark Beasley	25	124
5	Kim Alt	111	117
6	Ted Bohn	5	78
7	Gary Raymond	3	33
8	Jim McClain	309	8
	SATURDAY		
1	Rick Doran	40	142*
2	Dann Parks	2	135
3	Mark Murphy	9	133
4	Clark Beasley	25	132
5	Kim Alt	111	123
6	Jim McClain	309	122
7	Ted Bohn	5	119
8	Gary Raymond	3	90
NA	Olaf Bleck	28	126

* new track record: 32.407 miles

	SUNDAY		
1	Dann Parks	2	139
2	Mark Murphy	9	137
3	Gary Raymond	3	132
4	Clark Beasley	25	130
5	Ted Bohn	5	123
6	Kim Alt	111	120
7	Bill Burton	309	117
8	Rick Doran	40	104
NA	Olaf Bleck	28	101

WEEKEND LAP TOTALS

Pos.	Veh.	Laps
1	2	409
2	9	402
3	25	386
4	40	383
5	111	360
6	5	320
7	3	255
8	309	247
NA	28	227

Above: The starting grid for Sunday's Electrathon race at SEER'94.

measurement of the track revealed its length at 1205' long, so the total was only 32.4 miles. The track continued to eat tires, adding one of Gary Raymond's to its lunch at 90 laps. Still, everyone improved on their Friday lap numbers. Clark even added 2 laps to his '92 record best. Team New England showed its stuff with 126 laps in their "too wide" modified solar car.

Day Three: Sunday

Sunday's race was again a battle between the Cloudcar (#40) and my own Lightning (#2). We engaged in a speed dual averaging 36 mph for more than 10 minutes before I backed down. I picked up the pace again when Rick tried to lap me. This continued until Rick blew his front tire. My moped tires held out, and I went on to take first place. Mark stayed behind me in his Aerocoupe for 137 laps. Gary had fixed his earlier problems with tires, but a bad battery held him to third. Ted Bohn got it together with the #5 Slingshot for 123 laps and fifth place. Kim experimented with some solar panels on #111 for a little boost, but a taller gear ratio seemed to negate this and she couldn't better her numbers. Bill Burton took over the controls of the #309 car and stayed in the top four until a bad speed controller sidelined him for 5 minutes, dropping him to 7th place.

This was a great weekend for Electrathon racing. Three exciting races, new vehicles, new drivers, a new track record and lots of curious onlookers and potential participants. Five vehicles exceeded the '92 lap record. Note that all vehicles posted laps numbers within 14% of the leaders. Prize money (from registration fees) was distributed based on total laps for the weekend with everyone getting the same dollars per lap.

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Dann Parks, 764 Devonshire Way, Sunnyvale, CA 94087 • 408-733-2539

Following the Winds of Change

Dan Lepinski

Making electricity from the wind has been a dream for decades. Meet a modern wind energy pioneer who pursues this dream. Elliott Bayly, founder of World Power Technologies is a very down-to-Earth man with very up-in-the-sky ideas.

Beginnings

Ever want to make your own wind generator? Elliott Bayly did. Founder and president of World Power Technologies, Elliott became interested in wind energy as a child. “I grew up in rural Minnesota”, Elliott told me. “When I was six, while visiting my grandparents, I noticed a gasoline engine connected to a Delco 32 Volt DC generator and I learned what it was. A few years later, I discovered a Jacobs wind generator and realized that the wind could be used in place of gasoline to create electricity. I dug into it a little bit at that time. I learned that first there were gasoline driven generators that were used to produce electricity. When the wind generators came along, a big market existed for them to reduce gasoline consumption.”

Elliott’s fascination with wind power persisted, even years later. “As a teenager, I tried to build a wind generator, but it didn’t work”, Elliott continued. In spite of his early failures, Elliott’s interest in energy and electricity stayed with him into and beyond college. Tenacity was to become a prominent personal trademark.

Elliott graduated from the Massachusetts Institute of Technology with a BSEE. Shortly after, he obtained his Master’s from Stanford. In 1967, a PhD from the University of Minnesota rounded out his education. For several years, Elliott taught college, but it wasn’t his first love. A decision to move to Colorado changed his life dramatically. It would also forever affect the history of renewable energy.

Above: Elliott Bayly rewires a Whisper 1000 for 240 volt operation at this year’s Midwest Renewable Energy Fair.

The Dream Begins

“In 1972, I found myself in Steamboat Springs, Colorado where I got interested in building a commercial radio station. I decided to make it wind powered. The station, KFMU, went on the air on March 17, 1974. It’s still on the air and is still wind powered. It’s the world’s only wind powered radio station.” The radio station generated a lot of publicity for Elliott. Letters and phone calls poured in from people wanting to know where he got the wind generator. “Interest in wind power was starting to pick up at that time”, Elliott explained. “People were going around the country salvaging old wind generators. In the meantime, I had designed what I thought was the ideal wind generator with a permanent magnet alternator.” Elliott decided it was time to share his dream with the rest of the world.

A Whirlwind Affair

"In 1978, I started the Whirlwind Power Company and produced my first wind generator. I submitted that wind generator for testing by the U.S. Government at the Rocky Flats test site in Colorado. It was one of the first machines ever tested there. It's interesting to note that this wind generator started out as a small battery charging system for remote locations. In the early 80's, the government instituted very generous tax credits for renewable energy products. Everybody wanted to reduce their electric bills as electric rates were going up quite rapidly. Our market switched to bigger machines. We came out with a three kilowatt wind machine and an interface to connect it to utility lines, but our customers were all around Denver. The Whirlwind Power Company sold primarily in that local area."

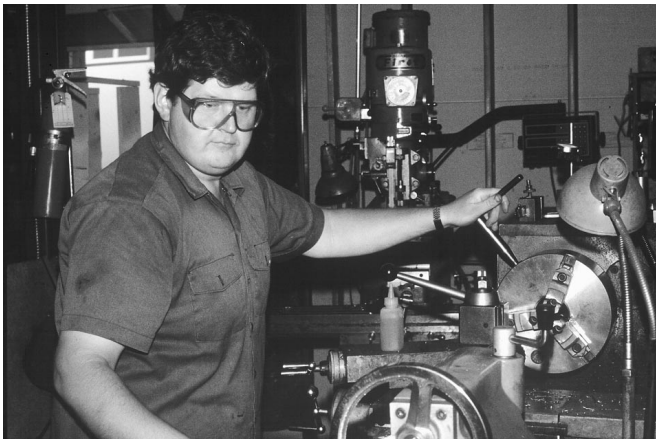
"In 1982, the whole country got hit with a terrible recession. I'd overestimated sales and overbuilt, and we went out of business. I was ready to close the business and move back to Duluth anyway. After moving back to Duluth, I got back into business and continued to build the utility interface machines. We ran until the end of the tax credits in 1985 when the bottom fell out of the market again. I closed the business in 1987 and sat back for two years restoring the building we're in and working on new wind machine designs".

"In 1989, I started World Power Technologies producing the Whisper wind generators. I broadened our focus to include both solar and wind as well as packaged systems ... and that's where we are today."

Puzzle Pieces

Whisper wind generators are a far cry from their predecessors. The Whirlwind machines were a maze of complexity. The Whispers boast only three moving parts. All pieces are carefully hand-assembled. Most of the components are manufactured by World Power employees. The rest are purchased locally or regionally whenever possible. Great care is taken to ensure a long and trouble-free life for each unit.

There have been no major design changes since 1989 when the first Whispers were made. Instead, modest refinements continue with each new generation. Recently, improved blades and blade configurations were introduced. The new blades, composed of either carbon-fiberglass or all carbon construction, are lighter and stronger than wooden blades. According to Elliott, field installable upgrade kits are available for existing Whisper wind generators. The newest offering from World Power is a utility intertie system. A three KW wind generator teamed with a Trace 4024 inverter offers renewable energy systems to grid connected and off-grid customers alike.



Above top: Brian Kokkonen, World Power's senior machinist, has worked with Elliott for 12 years. Many of the Whisper's parts are made in house by Brian.

Above center: Gary Gagnon cuts parts out with a plasma cutter.

Above bottom: Gary Gagnon makes Whisper blades using an automatic router. This machine uses a pattern bolted underneath its table.

So Where to from Here?
Elliott and his crew continue to advance the state of the art in wind generators. I felt privileged to get a glimpse of future products on the drawing board. It's truly exciting. With all these new ideas, I asked Elliott about his future plans.

"We have several medium and long-term goals", Elliott replied. "We're looking at offering two possible new machine introductions; a smaller machine, sailboat size or rooftop model, and something in the 15 kilowatt range to market to the Midwest farmer. I think we can market a model with a utility grid intertie that will have a payback period of less than 10 years, not to mention the tax advantages available for renewable energy equipment available in some states. We also want to produce a model that is simple enough so that the owner can install and maintain it."

"Our longer term goals include the production of a wind machine in the 5 to 6 kilowatt range. Experience has shown it's on the big side for battery charging for home power, and on the small side for a utility intertie. The market I believe that has the greatest potential for that machine is water pumping."

Tax Credits - Betterment And Bitterment
Though business today is strong, it was not always so. While running Whirlwind Power Company, Elliott rode through some of the roughest times experienced by the renewable energy industry. In the early 80's, the U.S. government made purchasers of RE equipment eligible for tax credits. I asked Elliott for his opinion of the credits as an incentive to bolster renewable energy usage.

"The tax credits are no longer with us. I don't think they should be. I think the proper incentive is to pay for production, not installing capacity. So the new approach, which is a penny and a half a kilowatt hour for renewable energy sources, is a much better way to go. It encourages development. The current administration has done a lot for renewable energies and we're quite pleased with the way things are going. The thing that is most prominent that the administration has done doesn't really affect our business. It's the Advanced Wind Turbine Development Program where a number of companies have been helped by the department of energy to develop the next generation of big wind turbines not for a utility interface, but for utility power. The help to us in the small industry has been relatively less, to not much at all. The conference just held in Puerto Rico dealing with renewable energy in the Americas was in part sponsored by our government. It was a way of promoting U.S. renewable energy technologies south of the border. I think that's very important. Presently, the international market is larger than our U.S. market. We sell about 60% of our production into other countries and about 40% into the U.S., although the domestic market is increasing steadily. It's been moving closer to 50/50 in the last year or two. Up until recently, the foreign market has simply been bigger. It's a little bit unique to our situation. When I opened World Power, I had a couple of strong foreign dealers. There's a tremendous potential market out there worldwide. Our problem at World Power is that we're so small that it's hard for us to have the marketing budget and people to get out there and do the marketing we should."

The Past Meets the Future
In the 80's, renewable energy tax credits provided increased momentum. Many companies entered the renewable marketplace. Few survived. If it can be said that history repeats itself, the wind generator industry would be a classic example.

In 1938, there were at least 24 manufacturers of small, home-size wind generators, according to Elliott. None are around today. I asked Elliott why.

"The depression era rural electrification program put virtually all of them out of business within 15 years. If that infrastructure had been permitted to remain and prosper, I'm sure beyond a shadow of a doubt that the rural areas today would have a lot more independent power systems and no utility lines."

"Back then, people wanted 'city' power. When they had their own electric system with batteries, there weren't the high tech inverters that we have today. It made the people 'different'. They had to buy special appliances. Their radios weren't as fancy. The choice of appliances just wasn't available to them like it was for city people. Anyway, running power lines was sold to them on an emotional level. `Be like the folks in the city and hook up to the power lines' they were told. So electricity was sold to them, and that's why a lot of them wanted to hook up to the power lines. That plus it was sold to them at a very low subsidized rate. It was economical. It was emotional. It was political. Wind power didn't have a chance."

"Today it's different. Our customers are people that are building a new home off the grid. These aren't just a hand-built log cabin or an A-frame or a tar-paper shack. They are some pretty significant homes; new homes. They are architectural designs that are incorporating solar power. The percentage of the population that's using wind power is infinitesimal, but we're hardly an industry. There's no infrastructure. You can't go down to your local hardware store or local building supply store and get any of this equipment.

The only thing you can get are solar powered sidewalk lights and gadgets, which I think is just fine. Simple things like the lights have tremendous educational value."

"I can see the use of a small wind generator on an outbuilding like a tractor shed...some structure that may be a few hundred feet from the house. If all they need is lights, it may be cheaper than hiring an electrician and installing wires from the house just to put electricity out there. It's a niche, but if they could buy what they need at a farm equipment supply house, they might do it. Another case could be watering cattle at a stock tank that is hundreds or thousands of feet from the power lines. Maybe they drive a water truck out to the tank on a regular basis or install a mechanical windmill which requires a pretty heavy dose of mechanical maintenance. The technology is there now for that farmer to use a modern wind or PV system to pump the water."

"I think we are in renewables where computers were in the early 70's, or possibly a little earlier. It's hard to look into a crystal ball and know exactly what's going to happen. If you start to get into pieces of property that are half an acre or more, you've got room for a wind generator."

"I believe the price of wind generators could come down dramatically. I don't like to say this, but if you look at a Whisper 1000 which weighs 50 or 60 pounds, it contains a lot of expensive stuff. There's stainless steel, electrical steel, mild steel, magnetic material, copper, fiberglass, wood, and an assortment of other things that recycle well. Compare it to a a lawn mower or a car — items that are mass produced. If you look at the selling price to the end user on a cost-per-pound basis, a lawn mower is four to five dollars a pound. A car is even less than that because it's mass produced, yet it's very exotic. An automobile has computers and other engineering which, for that car alone, cost millions of dollars. Every car has this background, yet the price is so low. Even a garden tractor is very inexpensive on a per-pound basis. Technologically, they're not that sophisticated. What are they? An internal combustion engine, a small alternator, a starter motor, a gearbox...there's a lot of stuff in a garden tractor, yet the price per pound is pretty low compared to a wind generator. There's a lot of potential for the cost of a wind generator to come down. If our production were ten times what it is today, I'll bet the price would be half or less what it is today. We're still a niche specialty market, but it doesn't have to be that way."

Elliott's Crystal Ball

For years, renewable energy systems weren't taken seriously. They were a novelty to most people. That's beginning to change. With that in mind, I asked Elliott what he saw for the future of wind power.

"I see the market for small wind growing quite large. The Chinese are the biggest manufacturers of small wind generators today. I've heard estimates in excess of 10,000 units and possibly approaching an installed base of 100,000 units. These are small home systems, portable systems for nomadic people, rural electrification projects, and the like."

"I also see small wind machines competing very cost-effectively with PV. Wind has had a problem with a bad reputation for reliability, liability, being too complicated, and too hard to install and service. Wind machines today are pretty much maintenance free and trouble free. A lot of people are trying them and are having good luck with them."

"I think we have a huge market right here in our backyard in Central and South America. I think the U.S. wind industry is very well positioned to take advantage of that market opportunity. Foreign governments are taking an initiative in extending electrification into rural areas. We're optimistic. Home power applications in other countries continue to grow and are a major part of our business. Rural electrification is just another home power market as far as we're concerned. In many places it's simply not economical to extend the power lines. The lines are long, the terrain is rough, and the customers are sparse. Along with the cost to install the lines, they have to hire crews to maintain the lines once they're installed. It can be a very expensive way to electrify a rural area.... a lot more expensive than putting in a hybrid PV/wind system."

Final Impressions

While visiting World Power, I was shown *the* original Whirlwind. It was made from a Rambler automobile brake drum. With a blade length of 12 feet, it was rated to produce one kilowatt. It's archaic by today's standards, yet it still works.

I didn't meet Elliott until recently at the '94 Renewable Energy Fair at Amherst, Wisconsin. A wiring problem with a transformer had the installers baffled. Elliott walked up and offered to help. Within minutes, he'd diagnosed the problem and had deftly rewired the Whisper 1000 to work with the transformer. As he worked, he answered questions, providing plain English instruction about wind generators to anyone who wanted to learn.

In spite of past adversity, Elliott remains remarkably optimistic. His open willingness to share his vast

knowledge exemplifies his attitude toward others. Elliott Bayly is truly a modern pioneer who follows the winds of change.

Access

Author:Dan Lepinski, Route 1 Box 268A, Exeland, WI 54835 • 715-943-2525

Elliott Bayly, World Power Technologies, 19 North Lake Avenue, Duluth, MN 55802 • 218-722-1492

The Rutland Windchargers

Things that Work!
tested by *Home Power*

Tested by Mick Sagrillo

Home Power's world of wind generators is host to the introduction of a new breed; the micros. These pint-sized versions of their larger cousins offer sippers of electricity (as opposed to us guzzlers) the same flexibility as incorporating a PV panel or two into one's system. The looming questions are, "Do they work? And will they last?"

To answer these questions, I decided it was time to find a niche for one of the wee ones. I contacted Peter Sanguinetti of Trillium Windmills in Ontario, the North American importer of the Rutland Windchargers. The Rutland Windchargers are manufactured by Marlec Engineering Co. Ltd., in England. Peter arranged for the shipment of a Furlmatic 910, including the import paperwork.

The wind generator arrived via UPS from Canada in two heavy-duty UPS-proof cardboard boxes. One box contained the generator, hardware, controller and instruction manual, while the other contained the blades and tail boom. The instruction manual is brief and to the point. It adequately addresses siting and safety measures for a micro-genny, assembly procedure, possible tower and mounting configurations, installation, plus tools and materials needed. There is even a section detailing a system design integrating PVs. Finally, consideration is given to inspection, maintenance and troubleshooting.

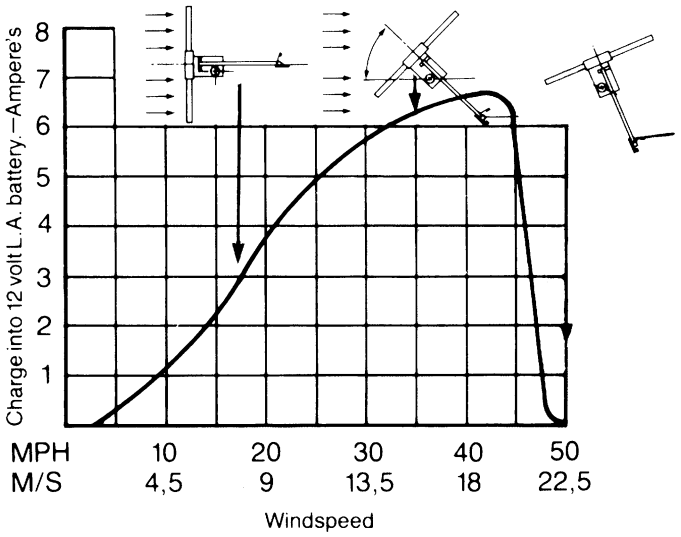
The Furlmatic 910 is Marlec's deluxe micro–genny. It sports a 36 inch six-bladed rotor. Lots of blades means easy start-up in low winds. The blades are made of fiberglass reinforced nylon in an injection mold process. My guess is that, short of vandalism, there is not much that will prevent these blades from going 30 years or so.

Above: The Marlec Furlmatic 910

The design of the generator itself looks somewhat bulky. The Furlmatic 910 reminds me of a bread box with blades and a tail. That criticism, however, is the only one I can come up with on the unit. The fit and finish of all of the component parts is impressive. All metal is either hot-dipped galvanized or protected with a polyurethane epoxy paint. All fasteners are stainless steel. The unit is advertised as "marine-grade", and I found no components that would not withstand the harshest of environments.

The Marlec specifies a standard 2 inch water pipe for a tower. We constructed a 42 foot guyed tilt-up tower for this and similar wind generators. (Note: this is the maximum height advisable using 2 inch water pipe.) The Furlmatic has a simple clamping system to attach it to the pipe. Wires run through the tower pipe and out the bottom. The Furlmatic alternator is a permanent magnet device with a bridge rectifier attached in its housing. Output is rectified to DC before leaving the unit.

Once the DC enters your power shed, it first travels through the optional Rutland shunt regulator before charging your battery. The shunt regulator monitors battery voltage and dissipates excess power as heat. Rather than purchase Marlec's optional metering, we added our own volt meter and amp meter to monitor output.



Above: The Furlmatic's output current versus windspeed curve.

The Rutland Windchargers are available in 12 and 24 volt configurations. We chose a 12 VDC system to float various batteries in the shop. The Furlmatic 910 did its job very well. It begins producing perceptible power in a very light wind, about 5 mph (see power curve). Several times we saw it peak at 8.5 amps before governing.

The Furlmatic 910 governs by side-facing the rotor out of the wind. The axis of rotation of the blades is slightly offset from the tower. As wind speed increases, the offset rotor furls itself around the tower and out of the wind.

One pleasant surprises is that this wind generator is remarkably quiet, regardless of the wind speed or load. Loaded or unloaded, the micro-genny's blades emitted a barely audible whirring sound. Under heavy load, we did notice that the unit gave off a resonant humming sound. While I am not positive about this, I believe that the sound actually comes from the electrical harmonic resonance interfacing with our guyed tower configuration. (Note: all electrical generating equipment utilizing rotating parts develops this characteristic hum.)

At one point, we connected the Furlmatic to three hydrogen electrolyzers, a nominal 6 volt load. Rather than stall the blades as I expected, the Furlmatic merrily churned out hydrogen!

Conclusions

At 36 pounds, the Furlmatic 910 is hefty for its output. While it only comes with a one year parts and labor warranty, the Furlmatic 910 is definitely overbuilt and designed to last for decades. I am impressed with the quality materials and construction as well as the performance of this micro-genny. With 20,000 of these little guys sold worldwide over the past 15 years. Marlec Engineering has the design down pat.

Quality, however, comes at a price. The Furlmatic 910 lists at $850 + UPS. For anyone on a small energy budget looking to hybridize their PV system by incorporating wind, I strongly suggest scoping out the Rutland Windchargers.

Access

Tested by Mick Sagrillo, Lake Michigan Wind & Sun, E 3971 Bluebird Rd, Forestville, WI 54213 • 414-837-2267

Manufactured by Marlec Engineering Co. Ltd., Rutland House, Trevithech Rd, Corby, Northants, NN17 1XY, UK. Phone (0536) 201558, Fax (0536) 400211

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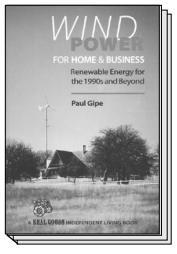

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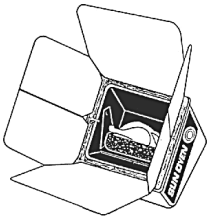

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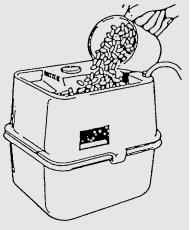

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724SB	700	24	12
DR1512	1500	12	70
DR1524	1500	24	35
U2512	2500	12	
U2512SB	2500	12	120
U2624	2600	24	
U2624SB	2600	24	60
U2232	2200	32	
U2232SB	2200	32	45
U2536	2500	36	
U2536SB	2500	36	40
U2548	2500	48	
U2548SB	2500	48	30
M1512	1500	12	70
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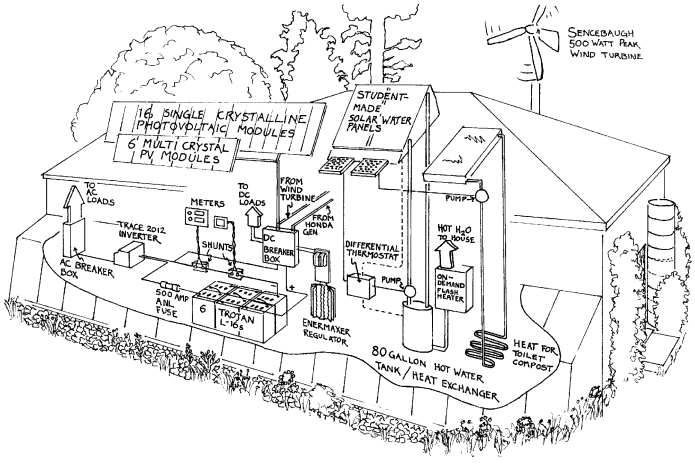
Above: The Campus Center for Appropriate Technology (CCAT) at Humboldt State University in Arcata, California.

CCAT System Upgrade

Nicole Whittick, co-director '94

Three students lounge on the rug in front of a fire in the middle of the fall semester at Humboldt State University (HSU) in Arcata, California. One is studying for exams, one is writing a newsletter, (she pauses every so often to dream about her Mac sitting idle in her bedroom), and the other is beading a necklace for his sister's birthday. They are all vying for space around the one DC bulb illuminating their evening.



Above: A cutaway drawing of CCAT's existing system.
Drawn by Chris Greacen

Above: Nicole Whittick, at home among CCAT's existing PV array of 22 modules donated by the Jet Propulsion Laboratories. CCAT has been off-grid since 1991.

A romantic example of the starving student life? This is actually a depiction of the "conservation-mode" adopted by directors of the Campus Center for Appropriate Technology (CCAT) when their electrical loads exceed the capacity of their PV system.

This is the second article featuring Humboldt State's Campus Center for Appropriate Technology, see CCAT: Pioneers of Urban Sustainable Living, Home Power #32. This article is the first of a two part series illustrating a system upgrade in a residential setting. The article is also part of a donation drive, CCAT's needs equipment and maybe you can help.

What is CCAT?

CCAT is an alternative energy and sustainable living demonstration home. The evolution of this successful and unique program has increased the electrical demands of CCAT from the needs of a three-person household to a heavily-utilized information center. CCAT is in need of a system upgrade, in terms of quantity as well as quality.

The house was leased to the student government at HSU by the university in 1978. The initial objective was to provide a base and an experiential learning site for a newly formed club of students who were moved by the fuel crisis in 1976. Over the years students interested in low-impact living have retrofitted the house into an example of residential efficiency. This May the program celebrated three years off-the-grid. Not only does the house have a self-sufficient PV system, it also has solar hot water , a solar-assisted composting privy, and one of the first models of the Sun Frost refrigerator.

The grounds boast chemical-free gardens, a greywater treatment marsh, a rainwater catchment system, a wind turbine used mainly for demonstration because of poor site conditions, a greenhouse supplying passive solar heat for the home and many other "appropriate technologies".

CCAT's Services

The program has grown from its orginal internal focus, building and experimenting with the various systems of the house, to a more external focus. Community outreach, free workshops, weekend classes, pamphlets on the systems and other informative activities have been the areas of growth for the program. These activities require electricity. Electricity for Econet and e-mail time, for desktop publishing, for answering letters requesting information, for searching our on-line library and for slide projectors and lights for

evening presentations which, ironically, are most in demand during the winter.

CCAT has also realized the goals of not just practicing what we preach but also analyzing the process. With system monitoring capabilities, the center will provide research and publishing opportunities for a whole new level of undergraduate and graduate studies. These pursuits require electricity. Collecting data, monitoring, and analyzing all demand more from our already taxed 22 panels (supplying 30 Amperes at 15 Volts with high sun) and 6 batteries (totaling 1050 Amp-hours).

CCAT has traditionally served many diverse functions. Solar and water quality engineering, environmental ethics, education and politics courses, appropriate technology, and even industrial technology classes use the workshop and resources available at CCAT to complete assignments and senior projects. There are also the many independent projects pursued by students to enhance their education. These are referred to as "instructionally related activities."

CCAT also has an extensive library, publication index and file system that provides information on numerous environmental and energy subjects such as strawbale housing, vermiculture, educational programs, internships and construction of thermal curtains.

CCAT's People

Three student co-directors live at CCAT full-time to demonstrate the capabilities of energy-efficient design in a comfortable residential setting. The students, who often take a light course load during their year as co-directors, are appointed by a steering committee comprised of professors, university administrators, peace-corps recruiters, community members and past directors. In exchange for living rent-free, the trio administers, initiates and organizes every detail of the program including the budget, tours, fundraising, educational opportunities, publicity, class projects, staff and volunteer scheduling, donations, maintenance of the systems and grounds, etcetera.

Fortunately CCAT also has a strong commitment from volunteers and part-time staff, who assist the co-directors maintain the grounds, build bigger and better solar ovens, flip the compost piles, braid garlic and to help with the many free workshops, presentations and lectures offered by CCAT.

Right: A Sencebaugh wind turbine donated in 1983 by the HSU Engineering Department. This turbine was installed by students and supplies a nominal amount of power because of poor siting. We are studying a more productive site and a higher tower to more efficiently capture the available wind power.

CCAT's Electric Power Consumption Estimate

#	Appliance	power type	hours/ day	watts	w-hrs./ day	%
	Old 120 vac Loads: lights, kitchen appliances, tools projectors, and VCR/TV (by measurement)				1230.0	37.7%
1	SunFrost refrigerator	12 VDC	9.8	55	540.0	16.5%
1	computer 1	120 vac	1.9	192	358.4	11.0%
1	network computer	120 vac	1.3	250	333.3	10.2%
2	Bedroom lights	12 VDC	2.0	75	300.0	9.2%
1	computer 2	120 vac	1.9	120	224.0	6.9%
1	office light	12 VDC	3.0	30	90.0	2.8%
1	vacuum cleaner	120 vac	0.1	780	52.0	1.6%
1	Bathroom light	12 VDC	0.5	75	37.5	1.1%
1	Greenhouse fan	12 VDC	5.0	6	30.0	0.9%
1	living room light	12 VDC	1.0	30	30.0	0.9%
1	battery charger	120 vac	2.7	8	21.3	0.7%
1	sewing machine	120 vac	0.2	114	19.0	0.6%
	Consumption estimate in Watt-hours per day				3265.6	

The office workers answer the numerous information requests flowing into CCAT, by mail, phone and e-mail. CCAT receives questions on greywater, solar energy, and how to start a "sister-CCAT" from as far away as South Africa, the Ukraine and Ohio.

The tours offered are taken advantage of by schools locally and from out of the area, from elementary to graduate level. Groups of students come from Oregon and the Sierra Institute has their students spend several days at CCAT as part of their course work. Just recently 40 students from an all-girl school in Tokyo toured the center.

CCAT is also a source of interest to development specialists globally. CCAT has hosted government officials from Uganda, representatives of an indigenous organization from Oaxaca, Mexico and Nicaragua. Local community members interested in intentional communities also use CCAT as a reference center.

Other people who take our tours are private home-owners. This is perhaps our most important audience. Based on the principals of supply and demand, these are the folks who will make the solar economy happen. The individuals and families coming to CCAT are usually already interested in PV power but want to witness a system in operation. People are referred to us by local solar equipment distributors, non-profit agencies and alumni of HSU. Local home owners attend our beginning PV design workshops along with students planning for their future. People drop by and take our self-guided tour, join an already scheduled tour, or request a tour ahead of time. We've had families drive down from Washington and Oregon to examine our system. Also, HSU students regularly take their visiting parents to CCAT.

Time for an upgrade

We need the energy storage capacity to meet our evolving program's increased needs. We need to present the latest and most attractive examples of PV technology. The funky character of the current system has served well as a student hands-on experimental center, but CCAT has steadily become a renewable energy advocate and information center serving a much broader base than the campus and local community.

Our most pressing need is a new battery bank. The current system has six, eight-year-old, 350 Ampere-hour Trojan L-16 lead-acid batteries. Heavy sulfation is evident and the total capacity of the batteries has greatly decreased.

With the knowledge that these batteries would have to sustain the center for a long time, they have been treated as well as possible under the high-load circumstances. The water levels are checked and logged monthly. A back-up natural gas generator is used when the levels get unavoidably low and to periodically equalize the batteries.

The scenario depicted at the beginning of this article shows the directors' reluctance to run the generator. In the past, electricity consumption has been carefully and dramatically cut back during times of low solar insolation. Anticipating an evening presentation by the International Development Technology program, (see Home Power # 41) or a workshop or perhaps a slide show by a returning Peace Corps volunteer, the directors will often go into "conservation mode", forgoing any unnecessary uses of energy. This means no computer time, studying in the same room, dinner by candlelight and no power tools.

The awareness of an impending need for new batteries spurred us to do a complete system appraisal. Using the results of a load analysis done by Arne Jacobson,

an Environmental Systems Engineering graduate with extensive experience in the Schattz-HSU hydrogen fuel cell lab, we have designed our dream system:

- 16 -350 amp hour lead acid batteries and rack
- 36 additional 50 Watt photovoltaic modules
- one 12 PV module tracker
- one Ananda Power Technologies power center
- one Omnimeter
- one Trace 4024 inverter

Whoa...says the reader. "Sixteen batteries and 36 more modules?" The above estimation of the center's needs are based on worst-case coastal Humboldt County weather patterns with consistent peak electrical usage and without relying on the back-up generator.

At CCAT we want to showcase reality and having an alternate source of power is realistic. We would ideally like to have a system which does not force us to operate the back-up generator any more than necessary for equalizing.

Our current system is a hodge-podge of single and multi-crystalline modules, some over thirty years old (which attests to the longevity of PV panels). We need newer panels and a tracker in order to showcase the latest developments in PV technology. Displaying modern, attractive and user-friendly equipment is necessary to promote solar energy; taking it from the "alternative" to the "mainstream."

In addition to increasing the capacity of the current inverter, a Trace 4024 would eradicate the buzzing from appliances, glaringly present during media presentations. A sine wave inverter would also be ideal because it would allow CCAT to depict a realistic situation for a residential solar system. It would illustrate the ability to sell excess energy back to the power company. An Omnimeter would be ideal for further graduate and undergraduate studies within the Environmental Engineering program at HSU. It would allow various energy data to be collected for analysis by students in solar engineering courses. We want to be able to present visitors with detailed charts and graphs that show the efficiency and effectiveness of our system. An Ananda power center would supply CCAT with a charge controller and an organized, centralized unit to showcase the components of a solar electric system. It will enable the visitor to see how simple it can be to operate current solar technology.

CCAT's wind turbine was previously mentioned as a supplemental power source. The 500 watt peak output Sencebaug wind turbine is mounted on a 40 foot tower at a site that often doesn't get the 15 mph winds required. The poor site location is due to zoning laws and university regulations. We are currently meeting with grounds administrators to see about improving the situation with donations of materials to increase the height of the tower.

Help!

The role CCAT plays in serving the students, community and solar advocates is unique. We are growing and our system needs to keep pace with our increased activities. If you can help with or contribute to CCAT's much needed system upgrade, then please do so. We will write a complete report on the upgrade and it will be published in *Home Power*. Thank you.

Access

Nicole Whittick, Campus Center for Appropriate Technology (CCAT) Humboldt State University, Arcata, CA 95521 • 707-826-3551 • FAX 707-826-3772 • E-mail:WHITTICKN@axe.humboldt.edu.

Special thanks to Paul Sitko, Michiko Mares, Michael Welch, Arne Jacobson, and Jack West for their assistance in preparing this article.

ask NREL

The National Renewable Energy Laboratory (NREL) is one of ten federally funded national laboratories. NREL has offered to provide answers to technical questions *Home Power* readers have regarding renewable energy.

Question: *Does it take more energy to make PV modules than the PV module can produce in 20 years?*

Answer: The question is about energy payback and sustainability. This question is often asked about PV, but is rarely asked about other energy sources (both non-renewable and renewable). Alexandra von Meier, a graduate student at the University of California, Berkeley, recently reviewed the energy requirements and energy payback of PV modules. The rest of this article is a summary of her review. Based on papers and discussions with manufacturers, she concludes that the energy payback time for PV modules ranges from 5–10 years for single-crystal silicon, 3–5 years for polycrystalline silicon and 0.5–2 years years for thin-film amorphous silicon. The main difference is the energy required for silicon processing. The trend is clear, but there is a lot of room for error in these numbers.

To calculate the energy payback time, the total energy investment in the module is divided by the modules expected yearly rate of energy production. However, the expected energy production is very dependent on location. The New England states receive about half the sunlight of the southwestern states. The total energy investment is also a difficult number to measure. It is more than the electrical energy and the equivalent energy of natural gas used by the module manufacturer. There is also an energy investment in the premanufactured materials, such as high purity gases, used to make a module.

The different studies also vary on the module parts to include. For example, should the energy investment in the module frame be included? Some manufacturers sell modules with and without the frame. More esoteric questions are "Do you include the energy investment in the construction of the manufacturing plant that made the aluminum for the frames?" These secondary energy investments are not included because there is already a lot of error in estimating the direct energy investments.

Reference

Alexandra von Meier, "Manufacturing Energy Requirements and Energy Payback of Crystalline and Amorphous Silicon PV Modules," Conference Proceedings of Solar 94, San Jose, California, June 1994, to be published by the American Solar Energy Society.

Access

Author: Byron Stafford, NREL

Send your technical renewable energy questions to: NREL, c/o Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179 voice/FAX . Email via HPBBS 707-822-8640 or Internet Email to richard.perez@homepower.org

Independent Power Providers (IPP)

Don Loweburg and Bob-O Schultze

In early August, Bob-O attended a meeting of the Utility PhotoVoltaic Group (UPVG) in Washington, DC. The UPVG is an organization of utilities, manufacturers and government-funded research groups. UPVG funding comes partly from membership dues and grants, partly from the sale of their reports, and MOSTLY from a Department of Energy (DOE) grant to study ways and means of involving utilities with photovoltaic applications. The DOE plans to spend 27 million between FY94 and FY96 in solar hardware and research projects as part of DOE's "Solar 2000".

Meet the UPVG

The UPVG membership of 85 utilities (out of more than 3000 utilities nationwide) is made up of mostly (over 50%) investor-owned utilities (IOUs) with most of the remainder a mix of Public Power and Rural Electric Co-ops.The 85 UPVG members provide electricity to 40% of all Americans. These are the major megabucks players, folks. Any one of them would make Microsoft look like a pushcart vendor by comparison. In addition to the utility members, a US PV manufacturer, a PV distributor, a few consultants and several state agencies attended the Washington meeting. The basic focus was a briefing about the UPVG Phase One report. This was followed by a very brief description of the upcoming Phase Two plan known as TEAM-UP (building Technology Experience to Accelerate Markets in Utility Photovoltaics). Whew! Can these Washington boys and girls turn a phrase, or what?

Phase One: Organizational and Strategy Development

The main purpose of this UPVG report was to examine potential options for utility PV involvement and recommend acceleration strategies for high volume purchases of PVs and balance of system (BOS) components. Toward those goals, the UPVG coalesced data from many government and utility studies, along with findings from a few of their own surveys, into a series of reports ranging from high school textbook level "What is PV?" explanations to complex hypotheses of the market value of various PV applications.

Phase One Conclusions

Some of the UPVG conclusions are based on real data from reliable sources while others were "best guess" given their self-imposed limited sources. Since none of their information came from "in the trenches" sources or reports like you might find in Home Power, UPVG has set itself up to be blindsided by new developments and long-term, hands-on data. A good example of this came from a chart labeled, "Example of Tracker's Impact on Coincidence". This incredibly inaccurate graphic showed a marked drop in PV output between 12:00PM and 3:00PM. The data points were graphed based on a single day where, apparently, there was cloud cover between those hours. Anyone familiar with typical PV output curves would NEVER have used such a chart in a final report of this magnitude. On the other hand, most current utility models for grid independent systems discourage trackers due to the permanency of the installation (steel pole cemented into the ground, etc.). Trackers can increase PV array daily output by as much as 40%, thus lowering the effective cost per watt. However, they don't fit into the "power in a box" concept that utilities like for quick deployment and removal in the event of payment default. Using an obviously flawed chart and extrapolating data from it shows tracked PV in a much poorer light. Given the utility rationale for a fixed array based on cheaper deployment or disassembly costs, the decision to use this particular chart begs a question. Did UPVG make such an obvious mistake due to inexperience or was there some other motivation?

From where we sit...

From the IPP perspective, recommendations of Phase One to aggressively pursue the grid-independent market were the most cause for concern. The UPVG Advisory Board recommends that utilities begin offering grid-independent systems as a profitable way to gain PV experience. No IPPs or PV industry types were involved in the Advisory Board process. The PV

manufacturer's representative in attendance at the meeting was Gerald Braun, director of utility business from Solarex. Mr Braun stated that he wondered whether the UPVG conclusions were based on existing industry and utility inputs or ...? He suggested that this is the time to expand UPVG inputs and get a "gut check" with the industry. From our observation, the UPVG Executive Director, Jeff Serfass, was clearly not amused nor receptive to the idea. Mr Braun went on to say that the independents were the ones who bought nearly all of their PV production earmarked for the domestic market and, frankly, Solarex was concerned about alienating IPPs. For me, it was a great insight and revelation. My take on Mr Braun's statement was that while utility PV purchases, many of which are contingent on partial DOE funding, may be the pie in the sky, IPPs are the proverbial bird in the hand. It was an incredibly gutsy statement to make, given the circumstances, and anyone in a position to give Mr Braun and Solarex thanks for their support should do so. Thanks, Gerald!

At the same time, it seems like a good idea to remind the other PV and BOS manufacturers of the mutual benefits of our current relationships. Any mass-buy deals they may consider with utility consortiums must be viewed in terms of their effect on their long time IPP customers. An IPP consortium, buying from selected supportive manufacturers, is a real possibility. We're independents, but we'll do whatever it takes to compete with the utilities either on or off-grid if necessary. Renewable energy is both our livelihood and our avocation. With the utilities, and the IOUs in particular, renewables are factored in primarily as they affect dividends.

Phase Two: TEAM-UP

TEAM-UP was a proposal by the UPVG to the DOE made in September,1993. It involves volume purchases of PV systems for large scale utility applications (LSAs) such as substation T&D (Transmission and Distribution) support, demand side management on commercial buildings and residential subdivision rooftop PV systems. Another part of the proposal included small scale applications (SSAs) which are primarily grid-independent applications such as off-grid homes. The proposal asks for nearly 1/3rd funding ($160 million) in subsidies from the federal government for the LSA installations. It is this government funding which is supposed to "kick start" PV production and lower the price per Watt. While the current plan doesn't call for subsidies for off-grid applications, it's this same government funding which will allow the utilities to buy PVs for their off grid schemes at an unfairly depressed price.

Where We Go From Here

The flavor of the TEAM-UP proposals to date indicate that the utilities will go ahead with most of their PV projects only if some percentage of DOE funding is forthcoming. Since this funding is far from certain and the final amount is anybody's guess, the PV manufacturer's reluctance to jump on board is understandable and even predictable. The IPPs, on the other hand, will continue to grow and service the market in the absence of government intervention as we always have. Unfortunately, this steady but slow growth will not, by itself, achieve the one goal that IPP, DOE, the utilities, and the rest of us have in common—the cost-effective deployment of PV nationwide. To achieve this goal as soon as possible, the IPP and the manufacturers will need assurances that any government funding and support be made available to all the stakeholders, not just to existing monopoly utilities. In plain language, if the DOE is going to help with utility PV purchases, it needs to provide funds for IPP purchases as well. Additionally, any help or access we can get toward a fast track to PV system acceptance by standard government loan guarantors (Freddie Mac, Fannie Mae, etc.) for homeowners will greatly stimulate PV purchases, yet costs the taxpayers almost nothing. This simple adjustment to existing HUD policies will do more to stimulate PV acceptance than all the proposed utility subsidies for PV put together. It is politically correct, socially correct and again, costs next to nothing.

A level playing field is all we require. Let the competitive market sort it out from there.

California Update

Last issue we reported on some of the details of Southern California Edison's off-grid program and the way they will go to bid. To date, this is how it will happen. Edison qualifies a customer and sends an Edison employee to the premises to do a load audit and establish site information. The information is used to put out a bid for a specific KWH/day PV system. The vendors will determine exact system details to meet this need and bid on the sale and installation of the system. Simple? Well no, not really. Our problem with this is that we are dependent on Edison personnel to gather the most important information; average daily load size. This single number is so important that I wouldn't be comfortable basing a design on information determined by another party. I know from years of experience in the field and from many workshops I have given, that pinning down this KWH/day number to a realistic value relies heavily on good customer interviews and education. If you don't get this right, you will have one unhappy customer. A well-designed

system also allows room for future expansion. Other IPP members and industry representatives have also made this point. I have gotten negative feed-back about the high insurance requirements and other liability questions associated with the program as well. Pending successful compliance with all CPUC requirements, the SCE program is due to begin this fall. While continuing our opposition to utility off-grid ventures, IPPs will participate in the program. We will also continue to be a part of all hearings and meetings on the off-grid program.

IPP continues to participate in meetings concerning on-grid PV applications as well. As stated earlier, we generally support utility on-grid PV. One issue of contention has come up. There are proposals that would allow the utility to install utility-owned PV systems on residential rooftops. These systems would be connected to the utility-side, rather than the customer-side of the meter. The residential customer might receive a small rent or probably pay extra for the privilege as with SMUD plan. The UPVG calls this "PV-friendly pricing". Friendly to whom? The utility customer participating in such a program would receive no benefit from the power generated from the PV system and would have no incentive to reduce loads in order to further reduce their bill and increase their power independence. IPP can not support this kind of utility sharecropping on your rooftop!

IPP has proposed programs in which the customer owns the PV system and the power is connected on their side of the meter. The utilities may offer financing for these systems as they have in the past for insulation and other energy efficiency measures, but early indications are that they will not. The utilities prefer to own or control the means of power production and "rent" the power as they have always done. Viewed strictly from the utility standpoint, this makes perfect sense. The profits are much higher and the opportunities for control and expansion of their monopoly into solar electric generation are far greater.

No matter who owns the PV system, the utility benefits from the deployment of PV on their grid due to the T&D value of localized generation and reduced "peaking" costs. You'd think they would be willing to contribute financially or at least offer net billing to encourage customer-owned PV generation. A few progressive thinking utilities do offer net billing programs, but most, especially many of the the IOUs, will not unless required by state mandates or a revision of the federal PURPA law. (See Carl Berger's letter and Mick Sagrillo's answer, in the Letter section, of this issue for an explanation of net billing.)

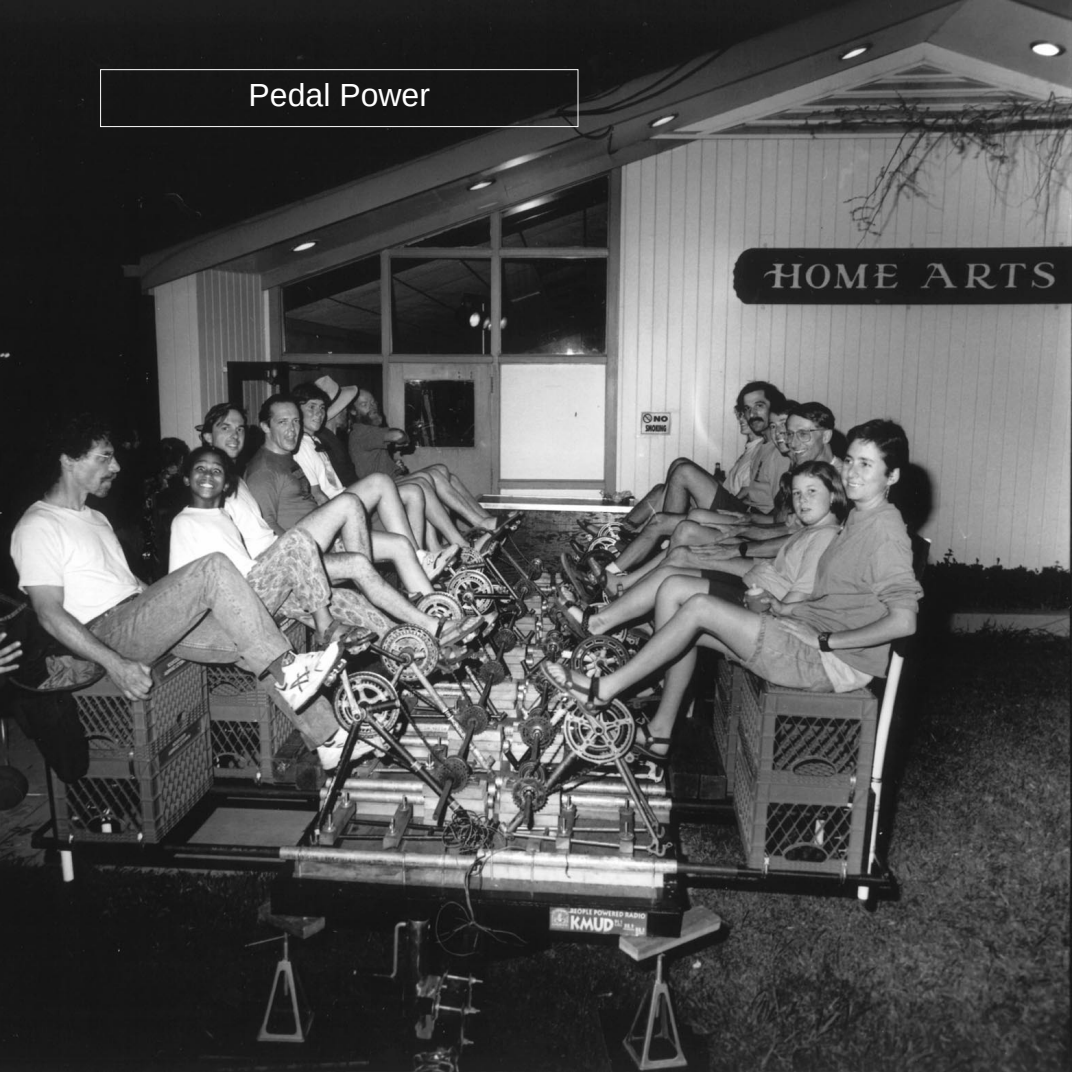
The IPP and You

By the time you read this, Independent Power Providers will be a non-profit California corporation. Federally certified tax-exempt status is applied for and will be in place long before the end of the year. We're in for a long and pitched battle against forces whose power and pockets are deep almost beyond imagination. What is at stake is nothing less than control of the solar electric resource here in the USA. If we allow the utilities or mega corporations to control the price, production, or distribution of PV, we give up one more facet of control over our own destinies and those of our children. These are the same folks who brought you Three Mile Island, Rancho Seco, Trojan, and nukes for peace, remember? Do we trust them with the sun? We think not. IPP needs your support. Help if you can.

Access

National: Bob-O Schultze, Electron Connection, PO Box 203, Hornbrook, CA 96044 • Fax/Phone 916-475-3401

California: Don Loweburg, Offline Independent Energy Systems, PO Box 231, North Fork, CA 93643 • 209-788-7080



Above: H.E.C.-klers pumping out Watts at SEER '94.

What the H.E.C.?!

Bart Orlando and Todd King

That might have been your reaction upon strolling just outside the SEERs Saturday night dance and discovering that the entire dance concert was being powered by the human energy converter, or H.E.C. for short. A crowd of enthusiastic onlookers took turns converting peddle power into electrifying rock n' roll. Fourteen peddlers, (or H.E.C.-klers), literally cranked up the music while keeping time to the tempo of the tunes. Tears of joy, (or was that sweat?), filed the eyes of the H.E.C.-klers as they called out to their compatriots, encouraging them to join in the fun.

The H.E.C. is a mobile demonstration. It's a human powered electric generator capable of putting out 1 KW. The output, averaging 800 Watts, depends on such factors as the mood of the music and the attitude of the H.E.C.- klers. All of the technology employed on the H.E.C. has been common knowledge for nearly a century. The materials used in its construction are readily available at recycling centers, scrap yards, and hardware stores. The parts list includes 14 bottom bracket assemblies cannibalized from scrapped 10 speed bikes. These are each connected to one of two common drive shafts via chain driven, free wheeling sprockets. Each shaft drives one of two Scott 24 Volt 1/2 hp permanent magnet DC generators via an 8:1 gear reduction. The two generators run at about 900 rpm (1/2 their rated rpm), and are wired in parallel to yield about 30 Volts. The peddling cadence averages about 70 rpm.

Et Tu Brute? No Way Dude!

The Dynamote Brutus 24 Volt 3,200 watt sine wave inverter, (on the far side of 220 Ampere -hours of exide battery storage), provided non- stop, ultra-clean electricity for the band and the PA system all evening.

This particular unit is a prototype for a human powered concert shuttle bus that can also provide power for an event. By powering events that draw large numbers of people, the idea of human energy conversion can be spread far and wide. We believe the long term deleterious consequences of using fossil fuels and nuclear energy will discourage civilization from following its current path and that the long term benefits

of providing economic incentives for people to exercise in health spas converted into human power plants will be our ultimate reward!

The Human Power Converter
Consider this. If 200,000 people in a major population area were to ride exercise machines in their own homes for one hour during the peak demand window of the utility serving that area, at approximately 74 watt/hrs/person (a good workout) some 14.8 million watt hours could be contributed to the utilitie's peak window. What about all the health spas in our nation?

Formulation
With this perspective in mind, we set out to build something which could tap into the potential of this resource. We had seen many systems which utilized one person, usually on a pedal assembly of some kind, to perform some task. Occasionally, we would see one which would do multiple tasks, but we had not seen any systems which used more than one person to perform more than one task.

We wanted the system to be portable, simple, user friendly, and easy to maintain. It also had to use as many recycled parts as possible (because of our low budget), and it needed to be easily replicated so the idea could grow.

Design
We decided that the bicycle design was the most common and tried, so we figured that the ultimate structure of the machine would be bicycles on a trailer. The bikes would turn shafts. The shafts would be connected to generators, which would charge batteries. With charged batteries we could power whatever we wanted.

Try #1
The first unit built consisted of two 1 1/4 inch shafts mounted on a trailer which could be towed behind a car. Connected to the shafts were two 24 Volt permanent magnet motors. The motors spin at about 1100 RPM rather than their rated 1800 RPM of charging voltage. Nine bicycles were strapped to the deck of the trailer with the rear tire resting on top of the shaft, so that when the bicycle was pedaled the shaft rotated. Given the inherent losses of a friction drive system, the first unit was limited to a top voltage of 18 and current levels around 20 amps. This would be sufficient if we were going run equipment at 12 Volts. However, we wanted to charge a 24 Volt battery bank. With nine people pedaling, we should have been producing about 600 Watts. An output of 360 Watts represents a pretty low efficiency.

Redesign
We decided to redesign the unit. We favored a system with pedals which would be permanently mounted to the trailer deck. We discarded the friction drive for a more efficient chain drive, removed the flywheel and idler sprockets, and exchanged the 1 1/4 inch shafts for 3/4 inch shafts. Seat assemblies were fabricated which would have adjustable seat backs and could accommodate different leg lengths.

This version seated 14 people. It produced 900 Watts (30 Volts at 30 Amps) as long as they pedaled. At a theoretical design output of 1036 Watts, we vastly improved the efficiency over the previous system.

It Works!
So far the second unit has powered many events with human energy, for a total run time of about 11.5 hours. At an average output of about 750 Watts, that represents about 8.6 kwh of energy produced to date. Not a large amount of power, but if one were to buy this amount of electricity from my local utility it would cost from $0.60 cents to $2.15 depending on the time of day and year.

Our goal was not to produce the least expensive power. Our goal was to provide an avenue for the conversion of the vast human resource to a medium which can be stored and later used for any purpose desired.

Future
What's next? We would like to experiment with systems utilizing power transfer techniques other than pedals and chain drive. We are intrigued with the potential of hydraulic transfer systems and their corresponding efficiencies. We would like to explore the potential of the full body work-out system, i.e. rowing machines and other Nautilus™ equipment. The additional power gained by incorporating the upper-body muscles could increase the available power.

We envision a day when the machines in health spas and work-out rooms could help power a central storage system which powers not only the health spa, but other grid customers as well.

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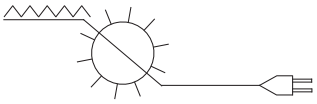

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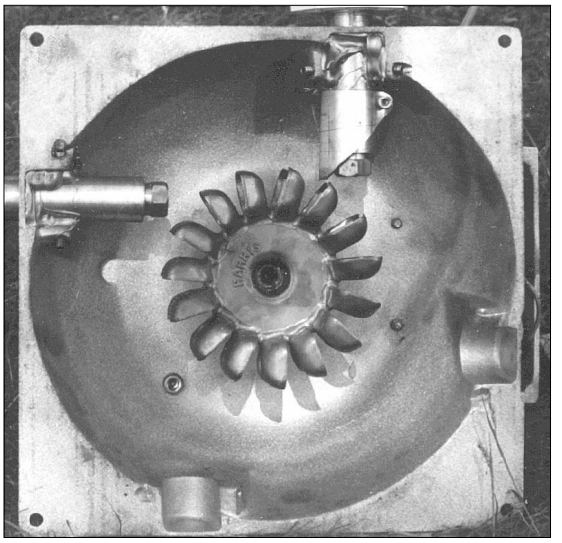

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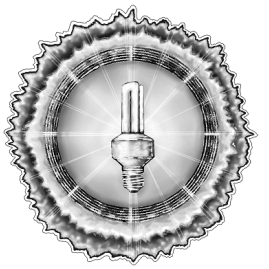

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If We're Going To Deregulate, Let's Do It Right!

Michael Welch

The biggest energy industry buzz-word these days is "deregulation". Utility deregulation translates to increased competition between energy producers. I'll explore several aspects of deregulation: what it means to the future of renewable energy; what it means to folks that want to be off-the-grid; what it means to the environment; and what it means to utility ratepayers.

It's our hope this will arm you with enough information to act. When utility deregulation is considered in your state, you'll be able to help your government agencies implement deregulation in a safe, sound and fair manner.

I'm not against deregulation (for my purposes here, "deregulation" means energy industry or utility deregulation). Even if I were against it, it seems to be gaining a momentum of its own. It may be unstoppable. I believe what the public needs to do is shape it, as best we can, rather than fight it.

I find it exciting that power consumers could have a choice among power producers. This is really the overall definition of deregulation. In its simplest form, deregulation means that I (or anyone else) can make the decision not to buy power from the local utility that, in most communities, has held a monopoly since the beginning. I would be free to contract directly for my energy with any other electricity supplier, even if it were a PV plant 2 states away. In the electrical industry, this is called wheeling: the use of one utility system's transmission facilities to transmit power of and for another system.

With this freedom, I could make a choice for cheaper rates, cleaner production methods or other criteria I may wish to apply. This is a great thing. But herein also lies the biggest problem with deregulation: the largest single consumers of electricity are industrial users, and we all know that most huge corporations have no conscience. They will opt for the cheapest power available, regardless of the consequences.

That, in fact, has been the impetus for states to examine the possibility of deregulating power sources. The deregulation effort originated with powerful business interests and their minions that were placed in utility regulatory positions. Consumer advocates have been pushing for free competition in the electric market place for a long time. It's a sad commentary about our political system when it 's only being used by industry trying to lower their own costs.

The Deregulation Movement

There is large national interest in deregulation, especially in the wake of NAFTA and other trade agreements which could significantly increase the availability of cheap, foreign-made electricity. Right now, consumer advocates, environmental activists, big industry, federal regulators and utilities are all watching the events in California. Last April, the California Public Utilities Commission (CPUC) issued its sweeping deregulation proposal.

Other states and even the Feds tend to follow California's lead regarding energy policy. If the CPUC's proposed deregulation methods become the law in their state, it could impact the whole country. There's been talk in federal agencies and Congress about taking deregulation out of states' hands. There are already Federal Energy Regulatory Commission rules that will affect how states deregulate. But California and other states will have finished their processes by the time the Feds get something going. California will likely become a model for other deregulation efforts. This makes it imperative that California's regulations be appropriate.

NAFTA and other trade agreements are helping to set the scene for national and international wheeling by allowing foreign power producers to compete directly with United States producers. Sounds fine until you realize these foreign producers are usually extremely hard on the environment.

Renewable Energy Sources Lose Out

The CPUC's version of deregulation has problems. It ignores the external costs of choosing power sources. Power purchasers would be able to choose suppliers that neglect environmental and other costs. For example, buyers considering only cost savings could choose cheap, unregulated coal-fired power from Mexico where environmental regulations are lax, or cheap but extremely destructive Canadian hydro power, instead of more expensive tightly-regulated power from the U.S. Taking this one step further, U.S.

plants could have reason to fight the current regulations on the grounds the cheaper foreign plants have an unfair regulatory advantage.

Presently, one of the few things making renewables look economically feasible to producers is the absence of environmental costs. If you remove that advantage, very few producers using utility-scale renewables can compete.

Off-Gridders, Hold On To Your Pocketbooks

Many of us that are off-the-grid have been looking forward to a decrease in the cost of photovoltaic modules. Part of the drive toward cheaper production methods and expanded production capacity has been based on forecasts for increased utility-scale PV demand. If power consumers are allowed to purchase power based on cheaper suppliers whose prices do not reflect environmental considerations, then utilities and independent power producers will be less willing to risk installing more expensive photovoltaic systems.

Because utilities and independents may not be as interested in buying PV, manufacturers could be less interested in risking both R&D and production capacity investments. This means end-users may have to wait longer for module prices to come down.

On the other hand, deregulation could make energy independence look more economically attractive. Inherent in the concept of wheeling, utility transmission lines will still be needed to move power between producers and consumers. Utilities will still own most of the lines. It's likely that utilities will need to lower the costs of their power to become more competitive with other sources. They may need to shut down the more expensive and less competitive sources they currently use. This means they may need to derive more and more of their income from their transmission lines.

Utilities may be allowed to charge consumers and/or producers (on a per/Kwh basis) for power wheeled over their transmission lines. It also means there will be a lot of pressure to charge more for transmission line extensions on a linear foot basis.

Traditionally, line extension costs have been the gauge rural and remote power users have used to decide between utility power and making their own. The oft-quoted rule is if your home is more than a quarter mile from the nearest available power line, then it's probably less expensive to use solar electricity instead of paying the utility to extend. Obviously, there are many variables involved here. Solar insolation, power requirements and availability of a local installing dealer are but a few. Overall, an increase in line extension costs can make energy independence very attractive to new home builders. Unfortunately, it will also make fossil-fueled home generators look more attractive.

Environment Loses Too

Some environmental implications of deregulation have previously been discussed.Still, there is a big one that looms heavily. That is the potential loss of Demand Side Management (DSM) programs that have been heavily fought for in recent years. Simply put, DSM is utility and user investment in increased energy efficiency and conservation.

In some states, utilities have been allowed a return on investments in options other than building more power plants. For example, the CPUC allows Pacific Gas & Electric Co. to make a profit on purchasing and promoting energy saving devices for their power consumers, just as if they had used that same capital to build new power generating facilities. The theory is the decreased use of power through conservation and improved efficiency is even more valuable than the installed capacity of building a new plant because DSM is relatively benign.

With deregulation as it is being offered in California, there is little incentive for DSM. It will be tough for conservation and efficiency to compete with low priced power wheeled in from elsewhere. This is especially true with large industrial users who stand to gain the most from such programs. Once again, the environment loses out to big business.

Look Out Homeowners

Small power purchasers could end up with significantly increased rates under deregulation. In the past 20 years or so, utilities have been investing in very expensive power plants to meet perceived future energy demands. Gone are the cheap electricity days of tossing a dam across the local river or throwing together a coal plant without regard for environmental repercussions. Many utilities started to build nuclear power plants thinking they would cost a couple hundred million dollars — which ended up costing several billion dollars. These days, all electricity plants must meet strict environmental regulations which are costly to implement.

All these expensive power sources had one thing in common. Regulations guaranteed that utilities could recoup their investments in these plants and make a profit on construction and operating costs. Truly, the utilities had great power over regulators to be able to get away with shoving such expensive behemoths down ratepayers' throats.

There is another class of organizations that wield just as much influence. They no longer want to pay their

share of the costs from those expensive plants. Utility deregulation is the tool that big industry is using to avoid paying their fair share. In California and other states, government utility regulators (whose job description included regulating the utilities so consumers wouldn't get reamed by power monopolies), have been quietly replaced by business advocates intending to look out for commercial rather than consumer interests. The fox is guarding the henhouse while the chickens are coming home to roost (sorry, I couldn't resist).

It doesn't take a rocket scientist to see that the smaller ratepayers, still stuck with utility service, could be left holding the bag on the utilities' profit levels. California's CPUC deregulation proposal will allow industrial users to change to cheaper power sources in 1996. Small businesses and the home- owning ratepayer won't be allowed to choose other sources until six years later.

Nukes May Die

Deregulation could very well bode the end to nuclear power plant construction. It could even cause the closure of currently operating nukes. Given the choice of power producers, no person in their right mind would choose the most expensive of them all. In fact, even with things as they stand in California, it appears it would be cheaper for ratepayers to buy out and shut down nuclear power plants than to pay for their continued operation. Deregulation could speed that up.

What Should You Do?

When utility deregulation rears its head in your state, don't just let it happen. Don't become a victim. Be vociferous. Organize hearing attendance. Help educate your neighbors about what it could mean to them and the environment. In California, the process is happening right now. The first round of public meetings will be over before you read this, so it is important for Californians to write letters to the CPUC. Let your regulators know that you insist that:

- environmental costs of deregulation not be ignored
- all customers have meaningful power supply choices.
- sustained, orderly development of renewable energy sources will be pursued
- low income weatherization and other low income programs will be protected
- the momentum in achieving energy efficiency and conservation will be sustained
- the electricity distribution companies will be indifferent to its power supply sources
- any uneconomic utility generating assets (like nuke plants) will be fairly disposed of
- the electricity distribution companies' profits will not be linked to electricity sales volume

Errata

In my last power politics column on human radiation experimentation, I insinuated that heredity was a cause of cancer, when in reality, it only increases susceptibility to it. Thanks to astute reader Tim Vincent for pointing this out.

Access

Author: Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95521. (707)822-7884 voice, (707)822-8640 computer BBS

Send comments on California's proposed utility deregulation to: Public Advisor, California Public Utilities Commission, 107 S. Broadway Room 5109, Los Angeles, CA 90012

GOOD BOOKS

Box Beam Sourcebook

written by Phil Jergenson with Richard Jergenson

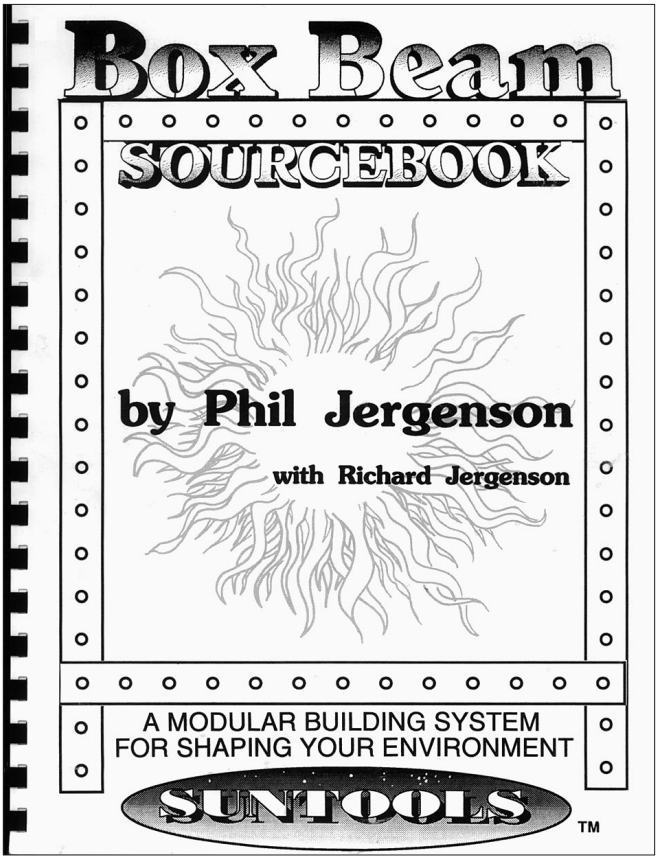
reviewed by Richard Perez

Phil Jergenson is a designer and builder of everything from houses to electric vehicles to furniture. Phil builds all of his creations from the same basic building block — box beam. Box beam is structural, square, aluminum tubing which has holes drilled on a regular matrix along all of its surfaces. Box beam is an erector set for serious grown-up design and construction.

I met Phil about five years ago when he was organizing the first SEER. I visited his Suntools workshop in Willits, California and was amazed at his box beam creations. All of his workbenches, general furniture, and several electric vehicles were made out of this bolt together framework. After a short ride in his Vanda electric vehicle, I realized that Phil was a genius on the order of Bucky Fuller. This guy was revolutionizing the design and construction of everything that surrounded him. Phil calls box beam, "A modular building system for shaping your environment."

The *Box Beam Sourcebook* is distilled, highly useful, information. The amount of practical detail that Phil has packed into 108, 8 X 10 inch, pages is amazing. Over one hundred photos and diagrams lead you step by step. First you make (or buy) the box beams, then you construct your design. In this book, Phil includes specific directions for the construction of the box beam itself, three buildings, nine electric vehicles, a wind generator and four pieces of furniture. All made from box beam.

Perhaps the greatest revolution in Phil's box beam modular construction system is flexibility. Let's say you've built your first electric vehicle frame using box beam. On the first trial run the vehicle scares you spitless in corners. You realize that the wheel base is too short and decide to move the rear axle six inches.



The box beam framework is easily unbolted, moved and rebolted. Think about doing this to a welded framework. Box beam's flexibility extends beyond design flexibility into reuse. If you no longer need a box beam creation, then its parts are easily reused. Yesterdays prototype electric tractor can become the kid's new bunk beds. Phil says that box beam is a "shape changer".

If aluminum is not your building material of choice, then box beams can be made from wood. Phil's furniture designs are easily user modified. Want that desk two inches lower or the bunk beds six inches higher? No problem, no holes to drill, just get out the wrenches and reposition the box beams.

The *Box Beam Sourcebook* belongs on every designer/builder's bookshelf.

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Box Beam Sourcebook is available from: Suntools, PO Box 1029, Willits, CA 95490 • 707-459-2624. The cost of the book is $23 postpaid inside the USA (CA residents add 7.25% sales tax) or $26 (US) outside the USA.

NEC and UL Requirements Too Conservative?

John Wiles

As the photovoltaic (PV) power industry moves into a mainstream position in the generation of electrical power, some persons question the seemingly conservative and redundant requirements established by Underwriters Laboratories (UL) and the National Electrical Code (NEC) for system and installation safety. This Code Corner will attempt to address those concerns and highlight the unique aspects of PV systems that dictate the requirements.

The National Electrical Code (NEC) is written with the requirement that all equipment and installations are approved for safety by the authority having jurisdiction (AHJ) to enforce the NEC requirements in a particular location. The AHJ (known as the electrical inspector) readily admits to not having the resources to verify the safety of the required equipment and relies exclusively on the testing and listing of the equipment by independent testing laboratories such as Underwriters Laboratories (UL). The AHJ also relies on the requirements for field wiring specified in the NEC to ensure safe installations and use of the listed equipment.

The standards published by UL and the material in the NEC are closely harmonized by engineers and technicians throughout the electrical equipment industry, the electrical construction trades, the national laboratories, the scientific community, and the electrical inspector associations. The UL Standards are technical in nature with very specific requirements on the construction and testing of equipment for safety. They in turn are coordinated with the construction standards published by the National Electrical Manufacturers Association (NEMA). The NEC is deliberately written in a non-technical manner for easy understanding and application by electricians, electrical contractors, and electrical inspectors in the field.

The use of listed (by UL or other laboratory) equipment ensures that the equipment meets well-established safety standards. The application of the requirements in the NEC ensures that the listed equipment is connected with field wiring and is used in a manner that will result in an essentially hazard-free system. Use of listed equipment and installing that equipment according to the requirements in the NEC will contribute greatly to not only safety, but also the durability, performance, and longevity of the system.

Sometimes Controversial Areas

The NEC does not present many highly detailed technical specifications. For example, the term “rated output” is used in several cases with respect to PV equipment. The conditions under which the rating is determined are not specified. The definitions of the rating conditions (such as Standard Test Conditions for PV modules) are made in the UL Standards that establish the rated output. This procedure is appropriate because of the NEC level of writing and the lack of appropriate test equipment available to the NEC user.

UL Standards

UL Standard 1703 requires that the instructions for listed PV modules contain specific requirements for the installation of such modules. The rated (at Standard Test Conditions) open-circuit voltage and the rated short-circuit current of crystalline PV modules are to be multiplied by factors of 125% before further calculations are made for conductor and overcurrent devices.

The 125% factor on the open-circuit voltage (Voc) is needed because, as the operating temperature of the module decreases, Voc increases. The rated Voc is measured at a temperature of 25°C and while the normal operating temperature is 40-50°C when ambient temperatures are around 20°C, there is nothing to prevent sub-zero ambient temperatures from yielding operating temperatures significantly below the 25°C standard test condition.

A typical module will have a voltage coefficient of -0.38 %/°C. A system with a rated open-circuit voltage of 595 volts at 25°C might be exposed to ambient temperatures of -30 °C. This voltage (595) could be handled by the commonly available 600-volt rated conductors and switchgear. At dawn and dusk conditions, the module will be at the ambient temperature of -30°C, will not experience any heating, but can generate open-circuit voltages of 719 volts (595 x (1 + (25 + 30) x 0.0038)). This voltage

substantially exceeds the capability of 600-volt rated conductors, fuses, switchgear, and other equipment. The very real possibility of this type of condition substantiates the UL requirement for the 125% factor on the rated open-circuit voltage.

For 24-volt stand-alone systems, this 125% factor presents a problem when using Square D circuit breakers which are UL-Listed for 48 volts DC. With a 44-volt open-circuit voltage, the 125% factor gives a system voltage of 55 volts which exceeds the 48-volt rating on the breaker. When a load center, like the Ananda Power Center, is listed as a unit, these breakers are tested at the higher voltages and are approved for the use. When the QO breakers are plugged into a Square D load Center (also listed for 48-volts DC), they should be used only for a maximum system voltage of 48 volts which means they are suitable for nominal 12-volt systems only.

The UL Standard 1703 also requires that the rated (at STC) short-circuit current of the PV module be multiplied by 125% before any other factors are applied such as those in the NEC. This UL factor is to provide a safe margin for wire sizes and overcurrent devices when the irradiance exceeds the standard 1000 w/m^2. Depending on season, local weather conditions, and atmospheric dust and humidity, irradiance exceeds 1000 w/m^2 every day around solar noon. The time period can be as long as four hours with irradiance values approaching 1200 w/m^2, again depending on the aforementioned conditions and the type of tracking being used. These daily irradiance values can increase short-circuit currents 20% over the 1000 w/m2 value.

Enhanced irradiance due to reflective surfaces such as sand, snow, or white roofs, and even nearby bodies of water can increase short-circuit currents by substantial amounts and for significant periods of time. Cumulus clouds also can increase irradiance by as much as 50%.

Another factor that must be addressed is that PV modules typically operate at 30-40°C above the ambient temperatures. In crystalline silicon PV modules, the short-circuit current increases as the temperature increases. A typical factor might be 0.1%/°C. If the module operating temperature were 60°C (35°C above the STC of 25°C), the short-circuit current would be 3.5% greater than the rated value. PV modules have been measured operating as high as 80°C. The combination of increased operating temperatures, irradiances over 1000 w/m2 around solar noon, and the possibility of enhanced irradiance certainly justify the UL requirement of 125% on the rated short-circuit current.

NEC Requirements

The NEC requires that the short-circuit current of the module, source circuit, or array be multiplied by 125% before calculating the ampacity of any cable or the rating of any overcurrent device used in these circuits. This factor is in addition to the UL required 125%. It is required because the terminals on most fuses, circuit breakers, and panel boards are designed and tested by UL to operate continuously at only 80% of their rated values. The 125% NEC factor ensures that these terminals are operated within their ratings and are not subject to overloading which can cause excess heating, expansion, loosening, and possible overheating of connected overcurrent devices. Both cable and overcurrent devices must be derated to avoid stressing these terminals.

Since short-circuit currents in excess of the rated value are possible from the discussion of the UL requirements above, and these currents are independent of the NEC requirements, good engineering practice dictates that both factors should be used at the same time. This yields a multiplier on short-circuit current of 1.56 (125% x 125%).

The NEC also requires that the ampacity of conductors be derated for the operating temperature of the conductor. This is a requirement because the ampacity of cables is given for cables operating in an ambient temperature of 30°C. In PV systems, cables are operated in an outdoor environment and should be subjected at least to a temperature derating due to an ambient temperature of 40°C. PV modules operate at high temperatures and in some installations as high as 80°C (concentrating modules operate at even higher temperatures). The temperatures in module junction boxes approach these temperatures and conductors in free air that lie against the back of these modules are also exposed to these temperatures. Temperatures this high require that the ampacity of cables be derated by factors of 0.33 to 0.58 depending on cable type, installation method (free air or conduit), and the temperature rating of the insulation.

Cables in conduit where the conduit is exposed to the direct rays of the sun are also exposed to elevated operating temperatures.

Cables with insulation rated at 60°C have no ampacity at all when operated in environments with ambient temperatures over 55°C. This precludes their use in most PV systems.

Redundancy and Conservatism or Not?

There appears to be little question that the 125% UL factor on voltage is necessary in any location where the ambient temperatures drop below 25°C. Even

though the PV system can provide little current under open-circuit voltage conditions, these high voltages can damage electronic equipment and stress conductors and other equipment by exceeding their voltage breakdown ratings.

In ambient temperatures from 25 to 40°C and above, module short-circuit currents are increased at the same time conductors are being subjected to higher operating temperatures. Enhanced irradiance can occur at any time. Therefore the UL and NEC factors for short-circuit current output and NEC conductor temperature deratings are not redundant.

Good engineering practice suggests that the UL Standard 1703 requirements and the NEC requirements are neither conservative or redundant and that they should be applied to all systems.

Implementation of these Requirements

The table below shows some common cable sizes (in free air and in conduit), the 30°C(86°F) ampacity, the 65°C(149°F) temperature derated ampacity, and the amount of short-circuit current (Isc) they can handle in typical installations. Underground Service Entrance cable type USE-2 cable has been selected for this example which has a 90°C insulation in wet and dry locations. A back-of-module temperature of 65°C has been assumed which is typical for installations in the US. For other cables and hotter or colder operating conditions, Tables 310-16 and 310-17 in the NEC should be used. A temperature derating factor of 0.58 is used and when combined with the 125% for the UL requirement and the 125% for the NEC requirement, the overall derating factor on the ampacity of the cable at 30°C is 0.3712.

	Installed in Free Air Ampacity			Installed in Conduit Ampacity		
Cable Size	30°C	65°C	Max Isc	30°C	65°C	Max Isc
14 AWG	35	20.3	13.0	25	14.5	9.3
12 AWG	40	23.2	14.9	30	17.4	11.1
10 AWG	55	31.9	20.4	40	23.2	14.9
8 AWG	80	46.4	29.7	55	31.9	20.4

To apply the table, just divide the short-circuit current of the module being used into the appropriate “Max Isc” number in the table. This will give the number of modules that can be connected in parallel using that cable size. If the number of modules in parallel is inadequate, a larger cable should be selected and the calculation repeated. Note that for long cable runs, these numbers do not take into account voltage drop. Also note that no more than three cables can be installed in a conduit. More than three require an additional derating factor to avoid overheating.

For example, a module has been selected that has a short-circuit current of 3.8 amps. With number 10 AWG cable in free air, five modules can be connected in parallel (20.4 / 3.8 = 5.4). Always round down for safety.

If the number of modules required to be in parallel exceeds the ampacity of number 8 AWG cable (the largest size that can be used with typical modules), then the array should be divided into subarrays with each set of subarrays protected by an overcurrent device.

Overcurrent Protection

The overcurrent device (fuse or circuit breaker) should have an ampacity rating of not less than 1.56 times the short-circuit current in the circuit being protected. This is derived from the UL and NEC requirements (125% x 125% =156%). The overcurrent device will normally have a rating less than the temperature derated ampacity of the cable.

For example, the five modules with an Isc of 3.8 amps each are connected in parallel with number 10 AWG USE-2 cable which has a temperature derated ampacity of 31.9 amps in free air from the table. The overcurrent device protecting this cable should be rated at 30 amps (3.8 x 5 x 1.56 = 29.6) which is less than the 31.9 amps ampacity of the cable.

In the next Code Corner, a series of examples will be started showing how the balance of systems (everything except the sizing of the array, batteries, and inverters) are designed for several different systems.

Access

Author: John Wiles, Southwest Technology Development Institute, Box 30,001/Dept 3 SOLAR, Las Cruces, NM 88003 • Phone 505-646-6105 FAX 505-646-3841

National Electrical Code, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269

Underwriters Laboratories, 333 Pfingsten Rd, Northbrook, IL 60062-2096

Do You Have Internet Access? - E-Mail Us!

Michael Welch

Communications is at the heart of information. After all, what good is information if you can't get it to people who need it? We're not in the publishing business just to sell magazines and ads. We're in it to get information into the hands of users and potential users.

We're always looking for new ways to distribute the info to ever widening circles. Hence comes our sponsorship of Redwood Alliance's computer communications system (Home Power BBS). For over 2 years you've been able to use a computer and modem to contact us and other folks interested in decentralized and renewable energy. To date, more than 1,200 of you have done so.

We've added a new way for you to contact us. Home Power Magazine is sponsoring the start-up of Internet E-Mail access via Redwood Alliance's BBS. This is exciting news for many folks around the world. They would like to communicate with us electronically, but don't want to pay long distance charges to call the BBS in Northern California.

What's This Internet Thing?

Internet stands for INTERnational NETwork. It was originally set up to help the U.S. Department of Defense share information among its geographically detached facilities. Slowly, other government agencies, universities and companies not connected with the defense industry got involved in Internet until it became what it is today. Most major companies and universities, and millions of individuals around the world are now hooked into the Internet to share computer data and messages.

Communications protocols have been developed that allow internationally (or locally) networked computers to share data and run software. These protocols are very complex and written in a computer language that is not normally available to home computers. That's one reason why a lot of people are subscribers to pay-for-use services like Compuserve, America Online, Prodigy, Delphi, and Genie.

Recently, software has been developed for systems like the Home Power BBS that allow folks to communicate within the Internet on a limited basis. One of the things that can now be done is Internet E-Mail. This allows anyone with access to Internet to send messages and data files to anyone else anywhere in the world. Of course, the receiver must also have an Internet E-Mail address.

The entire crew here at Home Power Magazine can now be reached by Internet E-Mail. In the past, you could leave us private messages on the Home Power BBS. For many of you, that meant calling the BBS by long distance. You can still do that if you wish. However, if you have access to the Internet, you can now get messages to us without calling all the way to Arcata, CA.

An address is the key to making sure messages get to the right computer and the correct recipient. The address tells the Internet computers everything necessary to route messages to their intended destinations. There are times when Internet addressing just doesn't work. Sometimes a networked computer that's supposed to relay a message loses it instead. This leaves the message in Never-Never land without a trace. In this regard, it's a lot like the US Mail. For critical messages, please our contact our BBS directly or give us a voice call. Generally, Internet E-Mail is considered very reliable.

The Home Power crew's Internet addresses are:

richard.perez@homepower.org
karen.perez@homepower.org
bob-o.schultze@homepower.org
michael.hackleman@homepower.org
therese.peffer@homepower.org
clare.bell@homepower.org
michael.welch@homepower.org
dan.lepinski@homepower.org
sam.coleman@homepower.org

You'll notice that all of us have the same ending on our addresses. That's what is called the "Domain Name". It's one we chose to make it easy to remember. The Domain Name extension is ".org", which is short for "organization", and means that this particular system belongs to a non-profit organization.

You, Too, Can Have an Internet Address

All users of the Home Power BBS can obtain their own Internet E- Mail address. Many of our users have a need to communicate with others that are already on the Internet. For a fee that is determined on a sliding scale of $2 to $15 per month (based on income), Redwood Alliance can set you up with an Internet E-Mail account on the Home Power BBS.

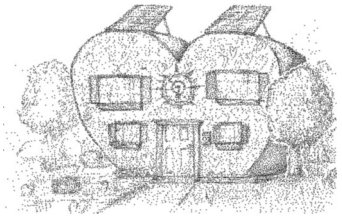
There are other options (like the online services previously mentioned) that may be more convenient and cost effective for you. Generally, if you have the need for more online services than just E-Mail, and/or there is an Internet provider with a feed in your local calling area, then it's better to get your E-Mail address that way rather than from us. Other online services typically charge a monthly minimum fee that gives you a fixed amount of online time. They then charge you by the minute for any excess above that base quantity.

In order to get an Internet E-Mail address through Redwood Alliance, you must become a Home Power BBS user, which is free of charge. With your computer modem, just dial the number listed in "Access". Once you have a little practice negotiating the system and have learned what the BBS offers, just leave a message for the Sysop (SYStem OPerator) stating you are interested in getting an Internet address. He will negotiate the price with you and set it up.

See you online.

Access
Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95521. (707)822-7884 voice, (707)822-8640 computer BBS

Home & Heart



Kathleen Jarschke-Schultze

Richard often says Renewable Energy powered homes are not the future, they are the present. With this in mind I visited the Tera 2 display homes that our local utility, Pacific Power, touted as the homes of the future. Hoo boy and I thought I was a conspicuous consumer.

Tera 2

Pacific Power claims their Tera 2 display homes are the "total energy resource application 2000, homes with the future built-in". These are actually two homes in a new housing development. Most of the homes in the same neighborhood were not even finished yet. Both were two story, three bedroom, two and a half bath, two car garage homes. The floor plans were different, but both included a home office, den, living room and dining room. Each had a spa in the backyard which used 240 volt heaters to heat the water. A local furniture and appliance dealer decorated the homes. The appliances were just for the show. They went back to the store, except for the built-ins.

Apples and Oranges?

I had Bob-O print-out the energy consumption charts for our system, (HP#41) thinking I would compare my household energy use to the Home of the Future. No such luck. Pacific Power didn't have energy consumption for the homes calculated or even estimated. I began in the first house by counting all the phantom loads.

Future Shock

I counted more than ten phantom loads in the first house. They were a compact disc player, amplifier, dual cassette deck, TVs, VCRs, built-in convection oven, microwave, assorted clocks, radios, a video security system, toilet (I'll get to that soon) and an electric 4-zone watering timer system. There were some electric gadgets I've never even heard tell of, like the Panasonic Intimist system. It's an electronically controlled paperless toilet. I'm not kidding. The seat is warmed for you, a jet of water is warmed for you and the blast of air to dry you off is warmed for you. You control all the different temperatures by a control panel on the toilet itself. That little item uses 120vac at 640W. All for the sake of warm buns.

Vacuums and Tubes

Each house had a different built in central vacuum system. I could see where that would be handy alright but the one system which gave power usage was 120vac at 1,180W. That is quite a bit more than my trusty old Kirby 525 at 350W. Air filtration, heat recovery systems and heat pumps with an electronic control system were also featured in both houses. The 45 inch color TVs with speakers probably sucked back a watt or two but the brochures weren't saying.

Ask for Asko

However, I was very impressed with the clothes washer, dish washer and clothes dryer chosen for the appliances. They were Asko brand from Sweden. The craftsmanship was obvious, stainless steel interiors, compact but sturdy. The two washers use a fraction of the water of their American counterparts. The clothes washer, a front loader, spins the clothes so dry that the dryer does not need to be vented. Alas, the dryer is 240v which puts it out of my reach. The washer uses about half the water and soap of the major American brands. I was told they were more expensive but no price tags were available. The dishwasher also uses a minimum of water and detergent, and runs very quietly. One of the fellows there told me people were always asking why they chose non-American appliances for their show houses. The answer is they wanted the most efficient appliances they could get.

UPS Unneeded

I was curious about the home offices. The computers were set-up and plugged in through a UPS (uninterruptable power source). I had never a UPS. The man explained that when there was a power blackout the UPS would warn me to save my current work and keep the computer going long enough to save. I explained that at my house we didn't have power blackouts since we were our own utility.

Kitchen Kitsch

One house had a Whirlpool refrigerator and the other had a Kitchen Aid. They are both part of SERP (Super Efficient Refrigerator Program). Both were side by side models with water and ice dispensers in the door. Neither had power usage figures in their brochures. The stoves and ovens were electric. The stove tops were set into Corian® counter tops with a vent which raised up out of the counter with the touch of a button. They did have sealed burners which was nice. Trash compactors were de riguer, again no specs on them. There were no provisions for recycling or composting.

Out in the Garage
In the garages the doors were electric, one double wide and two single wides. The first house had Pacific Power's EV, a GEO Metro that had the hood up and looked quite good. I particularly liked the big outlet in the wall, about 48 inches up, just for the EV. Every garage should have one of those. I was pleased to see Hydrocaps™ on the Trojan T-125 batteries used in the car.

Getting into Hot Water
Each roof sported a solar water heating system. One house used a Sun Family evacuated tube type and the other used a Copper Cricket. This was very good I thought but the toilet, the spa and the dishwasher all have their own water heating elements. Space heating was electric as was the air cleaning, cooling and circulating features. I asked one of the guys if the utility really wanted whole tracts of houses using this much electricity to run their assorted appliances and toys. He assured me Pacific Power did not have a problem with that at all and they could easily supply all the power needed now and in the future. An idle threat or short term boast?

Construction
The construction of the houses themselves were very thoughtful. The front door on one house was solid fiberglass, which has three times the insulation value of wood and won't peel warp or distort. They used dual heat pumps, one for upstairs and one for downstairs for greater efficiency. They both had composition roofs which uses less wood and is more fire retardant. An I-joist floor system from Boise Cascade uses 30% less wood fiber and is stronger and straighter than equivalent cut wood. The 2x6 wall construction used R-26 in the walls, R-30 in the floor and R-49 ceiling insulation.

Conclusion
The Tera 2 houses seemed to have every conceivable electric and electronic appliance, entertainment and security device invented. (Which of those categories does the toilet fall into?) Obviously, these homes were designed as on-grid homes so it is unfair to really try to compare them with off-grid homes. Still Pacific Power could learn a lot about conservation from off-gridders There were some compact fluorescents but a lot of the lighting wasn't because it didn't fit the decor. The picture I see is that when something goes wrong at these homes a repair person gets called. When something goes wrong at our house Bob-O or I grab the tool box and fix it. I thought my life style was self-indulgent until I saw a utility vision of the future.

Access
Kathleen Jarschke-Schultze continues to retrofit her vintage home in northern-most California c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 916-475-0830. Internet Email: kathleen.jarschke-schultze@homepower.org

HAPPENINGS

INTERNATIONAL
CANADA
Are you now operating diesel or gas generators with their high fuel and maintenance costs, or just doing without electricity. Have you ever wondered about energy available in falling water? This course will tell you how to determine the feasibility and cost-effectiveness of a low maintenance waterpower option (not necessarily nearby). Neither solar PV nor windpower can come close to competing with this technology.

This two day, twelve hour micro-hydro course is suitable for everyone, regardless of technical background. The course includes an overview of electricity & energy and terms & concepts. Upon completion, you will be able to assess the potential of your stream or creek to meet your electrical needs. Learn how to size system components,estimate costs, and have some basic installation guidelines. The cost of the two day course is $80 Canadian (approximately $57 US), October 22 & 23, 1994, University College of the Cariboo, Kamloops, BC V2C 5N3, 604-828-5039. For more course information contact Bob Mathews, course instructor, at 604-679-8589. Field trips and other course dates will be scheduled as demand requires.

FRANCE
The European Conference on Energy Performance and Indoor Climate in Buildings will be held Nov. 24–26 1994 in Lyons, France. Its aims are to discuss the results from research and development in solar energy applications and the rational energy use in buildings, to confront the views and needs of industry and professionals, to inform the European building community on the latest developments in the research and application of new building products and evaluation of tools and to discuss the possibilities for standardization of assessment methods and energy performance requirements on a European-wide level. The oral sessions will be in English and French. For more information contact, Ecole Nationale des Travaux Publics de L'Etat, Rue Maurice Audin, 69518 Vaulx en Cedex, phone 33-72047070, fax 33-72046254, telex ENTPE 370511F

GERMANY
The 27th Annual ISATA International Dedicated Conference on Electric, Hybrid & Alternative Fuel Vehicles will be held October 31–November 1 1994 in Aachen, Germany. The conference will focus on the most pressing questions in the world of Electric, Hybrid and Alternative Fuel Vehicles. For more information contact ISATA Secretariat, 42 LLoyd Park Ave, Croydon, CR0 5SB, England, 081-681-3069 Fax 081-686-1490

NATIONAL
American Hydrogen Association Bulletin Board System: Solar Hydrogen BBS, 415-494-3116, 1200–14,400 baud V.32bis. V.42bis 8N1, Prosperity without Pollution: also AHA Tempe BBS (602) 894-8403.

Free Energy-Saving Information for homeowners who would like to save money by improving the efficiency of their home. The Energy Efficiency and Renewable Energy Clearinghouse (EREC), is offering a free information packet on home energy efficiency measures. You may contact EREC by calling 1-800-DOE-EREC (363-3732) or by writing EREC, PO Box 3048, Merrifield, VA 22116 and ask for the Energy Savings packet.

2nd National Tour of Independent Homes, sponsored by Real Goods Trading Corp. October 15, 1994, 10AM–4PM. Call 1-800-762-7325 for information on alternatively powered homes available to tour near you.

EAST COAST
American Tour de Sol — National Road Rally Championship for Electric and Solar Electric Vehicles, May 20–27, 1995, Waterbury, CT—Portland, ME. For more information about the event, volunteering, participating, sponsoring, or exhibiting please contact Northeast Sustainable Energy Association (NESEA), 23 Ames St, Greenfield, MA 01301, (413) 774-6051, Fax (413) 774-6053.

ARKANSAS
Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. The focus of these seminars is to teach others how to build their own homes from materials that can last a thousand years and cost less than conventional wood-framed homes. These are hands-on, all day workshops. Contact Loren at PO Box 453, Hot Springs,AR 71902

CALIFORNIA
Real Goods Institute for Independent Living is offering a workshop, Oct. 14–16, 1994, at the Shenoa Retreat Center in Philo, CA. The weekend session costs $360 which includes three vegetarian meals per day and accommodations in non-smoking cabins. The workshop will cover: hands-on introduction to electrons, introduction to energy, the land, system sizing and design, hands-on system building, resource management, retrofitting, building strategies, water, information resources, home tour, alternative energy options, & technical consultation. For information and registration, call the Registrar at Real Goods at 800-762-7325 or write to Real Goods Institute for Independent Living, 966 Mazzoni St, Ukiah, CA 95482. Internships are considered.

SMUDs Brown Bag Series VII — every other Thursday, Noon to 1PM, at SMUD Energy Services, Conference Rooms 1 & 2, 6507 4th Ave ste 500, Sacramento,CA. Oct. 6—Advancing Utility Wind Projects: political & technical;Oct 20—Passive Solar Design with Structural Insulated Panel Technology; Nov 3—Landscape Design for Maximum Solar Benefit; Nov 17—Applications and Benefits for Solar Industrial Process Heat; Dec 1—Solar Water Purification for the Developing World; Dec 15—Cost-Effective Utility Photovoltaics Applications.

COLORADO
Solar Energy International (SEI) is offering workshops on the practical use of solar, wind, and water power. The 1994 Renewable Energy Education Program (REEP) features one and two week workshops: Solar Home Design Principles, Alternative Building Technologies & Passive Solar, Women's Basic Carpentry, Solar Water Pumping, PV Design & Installation, Advanced PV, Solar Cooking, Drying & Water Distilling, micro-hydroelectric systems, alternative transportation & EV Conversions, Hydrogen Energy. Guest speakers and professional instructors will teach the design of state-of-the-art solar homes that are self-reliant, energy efficient, healthy to live in, and earth-friendly. Participants will learn the knowledge and skills to build energy independent homes with solar, wind, and water power. The series is for owner-builders, industry technicians, business owners, career seekers, and those working in developing countries. The workshops may be taken individually or as part of a program. The cost is $400 per week. Scholarships and work/study programs are available on a limited basis. Contact: Solar Energy International, PO Box 715, Carbondale, CO 81623-0715 or call 303-963-8855.

FLORIDA
The 1994 ARRL 19th Annual Amateur Radio & Computer Convention will be held November 19 & 20, 1994 in Tampa, Florida. For more information contact FL Gulf Coast Amateur Radio Council, PO Box 2423, Clearwater, FL 34617-2423 or call Bill Smith 813-837-4533.

MASSACHUSETTS
11th Annual Quality Building Conference '94 — Making Sustainable Building Standard Practice: November 11–12, 1994 in Springfield. Expert builders will present practical, cost effective applications of the latest advances in energy efficient, sustainable design and construction, indoor air quality, and building science. QBC'94 will take a comprehensive look at the people,

economics and practices which are changing the way we think about and construct buildings. Workshops, technical presentations, demonstrations and a design competition will underscore the close connections between energy efficiency, sound business growth and environmental responsibility. In depth workshops will feature the Energy Crafted Home, Waste Reduction and Recycling and other topics. For more information contact NESEA, 23 Ames St, Greenfield, MA 01301 • 413-774-6051 • fax 413-774-6053

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516.

OHIO
Solar electric classes taught at rural alternative powered home with utility back-up. Maximum of 12 students. $30.00 fee per person, $35 per couple, lunch provided. Class will be full of technical info, system sizing, NEC compliance, etc. Students will see equipment in use. Dates: Oct 8, Nov 12, Dec 10, 1994. Jan 14, 1995. All classes held from 10:00am—2:00pm on Saturday. Call (419) 368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

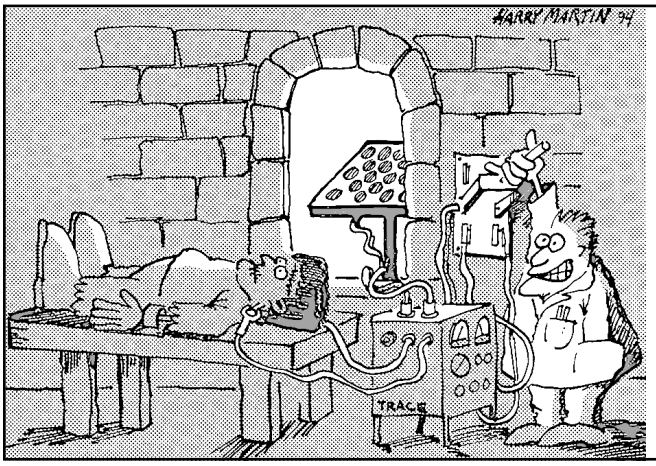
The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information contact, Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44 or (614) 899-6263, Fax (614) 899-1717. Internet address DUSSAULT@delphi.com.

VIRGIN ISLANDS
Real Goods Institute for Independent Living is offering a workshop, Oct. 31 – Nov. 4, 1994 The five day tropical Workshop costs $850 which includes six nights accommodations, meals and amenities at Maho Bay Resort located at Maho Bay, US Virgin Islands National Park. The workshop will focus on unique tropical concerns and techniques, development issues with special emphasis on preserving fragile tropical environments, using indigenous & recycling materials, minimizing development impacts on delicate patterns of life, and optimizing living in an equatorial atmosphere. The Maho Bay Resort is a sustainable resort in a pristine paradise, the workshop schedule allows time for visits around the island , so you'll get a good learning experience and a great vacation. For information and registration, call the Registrar at Real Goods at 800-762-7325 or write to Real Goods Institute for Independent Living, 966 Mazzoni St, Ukiah, CA 95482. Internships are considered.

WASHINGTON
Wednesday 7 to 9 PM, 28 September to 26 October 1994, Bellingham, WA. Design Your Renewable Energy System. Taught by Chris Greacen and offered through Northwest Freedom University. The class covers basic electricity principles, system types, determining power needs, solar electric panels, wind, microhydro, batteries, inverters and how it's put together—wiring, electric code, safety, instrumentation and controls. Class includes a half-day Saturday field trip to a local project. Contact Northeast Freedom University, VU, WWU, Bellingham, WA 98225, 206-650-3476 or Chris Greacen 206-468-2838.

WASHINGTON, DC
March 26–30, 1995—American Wind Energy Conference: Windpower '95. Contact Linda Redmond, Meetings Coordinator, AWEA, (202) 383-2500, Fax (202) 2505.

WISCONSIN
The Midwest Renewable Energy Association will be holding an on-going series of workshops. For more information call or write the Midwest Renewable Energy Association, PO Box 249, Amherst, WI 54406, 715-824-5166.



the Wizard speaks...

Cold Fusion

Although the phenomenon known as cold fusion is no longer being reported in the mainstream media much positive research is still being done. The effort is international in scope, ranging geographically from the USA to Russia and from Europe to the Far East. Net energy generation has been achieved with systems using not only palladium electrodes and deuterium electrolyte, but also with nickel and titanium electrodes, and light and heavy hydrogen in liquid and gaseous states. Results were also reported from such widely varying experiments as the use of proton conducting ceramics to techniques involving gas-plasma discharges.

Experimental Evidence

Analysis of reaction products in many, though not all, of recent experiments seems to indicate that fusion is actually ocurring. The presence of tritium, neutrons, and helium has been confirmed in some experiments, though not in quantities that can account for all the heat produced. In some cases, nuclear transmutation products have been found indicating that some electrolyte or part of the metallic lattice has reacted with the hydrogen. The virtual absence gamma ray emission has been puzzling, although some experiments have reported it.

Theory

Proposed ideas that explain the cold fusion process range from a novel type of "super-chemistry" with secondary nuclear reactions to a new class of primary nuclear reactions. The virtual lack of gamma radiation may be due to the absorption and transmission of reaction energy by the molecular lattice where the reactions take place.

Outlook

The outlook for cold fusion research is good. Many experiments are reproducible given the right precautions. Excess power in the form of heat has been reported up to a value of four kilowatts per cubic centimeter of cathode material. New methods of producing excess heat, such as hydrosonic pumps, are being discovered. An initial temperature differential may be necessary to make some procedures work.

A Caution

Ecological concerns are associated with any type of nuclear fusion. Hydrogen is essential to life, as an element in organic compounds and as a constituent of water. Do we really want to replace the biosphere's hydrogen with helium or other nuclear reaction and transmutation products? I think not! Large-scale use of any fusion technology could irreversibly damage the biosphere. Developing cold fusion is not the path to take. In the long term, it could easily lead to ecological disaster.

Access

Cold Fusion Magazine, 70 Route 202 North, Peterborough, NH 03458 • 603-924-0058 • 800-677-8838 • Fax 603-924-8613

Fusion Information Center, Inc, P.O. Box 58639, Salt Lake City, UT 84158 • 801-583-6232 • Fax 801-583-6245

Cold Fusion Times, P.O. Box 81335, Wellesley Hills, MA 02181

Letters to Home Power

Birth
A brief note on our recent solar powered home birth. Our daughter, Alice, was born the evening of June 29 at our home in South Hampton, NH. We'd had thunderstorms on and off all afternoon and just after calling the midwife to say "it's time to get over here", a neighbor I had called remarked that his power had been off for 30 minutes. Our PV/battery/inverter power setup and solar hot water have been meeting our needs since the equinox and Noone had been looking out of the windows, so we hadn't even noticed.

Now when someone asks me "How soon will the system pay for itself?" I can say "It already has...". Yours in the sun, James, Jocelyn & Alice Van Bokkelen, South Hampton, NH

Death
It is my sad duty to report that Jordan College Energy Institute in Comstock Park, Michigan is history. While officially closing at the end of the summer, the faculty and equipment have already gone their separate ways, the building is an empty shell... But it went out with a bang, not a whimper! The 1994 Michigan High School ELECTRATHON Competition took place as planned and the Ecoscort, a 1992 Ford Escort converted to a hybrid vehicle, finished fifth in its class in the Saturn/DOE/SAE competition in June.

The Electrathon competition was the largest race yet in the United States with seventeen cars on the starting line with ten of them covering over twenty miles in the allotted hour. The winning car came close to breaking the record of 35.6 miles with more than 34 miles, but had enough battery left that they're using the old saying "wait until next time!"

The Hybrid Electric Vehicle Challenge was the second try for the Ecoscort, having had severe problems with a junkyard motorcycle engine last year. This year Kohler was kind enough to give us a 25 horsepower, two cylinder engine that ran great! This car was designed and built by students with mostly off-the-shelf parts. John Sarge was the "prime mover" on this renovation. An eight inch Advanced DC motor gave reasonable acceleration and speed, the Trojan 12 volt batteries provided a 30 mile electric only range. The Kohler provided the long range capability through a free running clutch and a cogged belt drive. The batteries were located in place of the rear seat in a well that projected under the car. In case of an accident, the batteries would depart the car from underneath instead of through the driver's seat.

The car performed very well at the competition, even surprising our team by not giving an excuse for them to open their tool boxes. Very different from last year! There were qualifying runs to be made and inspections, then testing for EV range, acceleration and hybrid range, a road rally through city streets, and a commuter challenge that really put the cars through their paces. After accepting the fifth place trophy and a check at the awards banquet on June 20, Scott Nichols simply got in the car and drove it back to Comstock Park, a distance of some two hundred miles. This was done on the fuel left in the tank from the competition. Rich Libby was the second driver on the team, Jim Keyzer was a technical advisor, Jeff Dailey built a great microprocessor control for the car.

The faculty and the students of JEI are very sad to see the school close. It really was unique, with two and four year degree programs that covered solar, wind, biomass, micro-hydro, and electric vehicles. Every effort was made to allow those students close to graduation to complete their studies. Those that had only begun have no place to go where they can continue, except for a few places that cover a portion of the material. Many of the faculty will try to organize a group of renewable energy enthusiasts in the Grand Rapids, Michigan area. Life goes on.

The Electrathon competition will continue through a new company I call the Great Lakes Electrathon Association (GLEA). The primary mission of GLEA is the promotion of the Electrathon race as an educational tool for high schools in surrounding states. To accomplish this mission GLEA will provide the organization and expertise to a suitable sponsor. This will include initial contacts with the schools, appropriate literature, an event organizational meeting with all participants, a telephone and fax hotline, newsletters, grading of reports, publicity, and the event itself.

A secondary mission of GLEA is the promotion of Electrathon as a sport for participation by any individual or group. This will entail providing information on construction and design, as well as holding the races. These races, like high school races, will be held in accordance with the rules as published by ELECTRATHON AMERICA.

For further information contact the Great Lakes

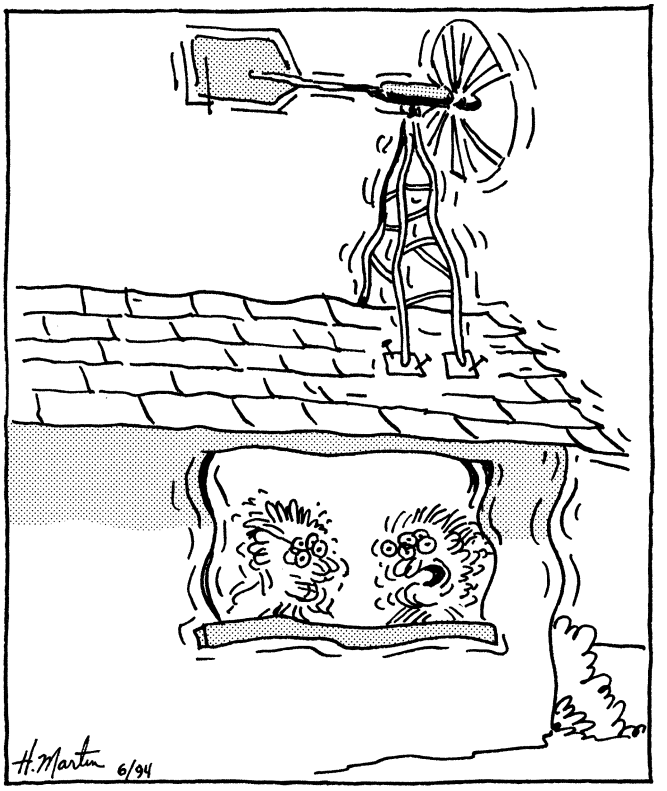
Electrathon Association, PO Box 224, Sparta, MI 49345. An SASE is appreciated. Telephone 616-887-2744, Fax 616-887-7755. Paul Zellar, 54 W Averill, Sparta, MI 49345

Dear New Zealand
In early 1995 my husband and I will be making a tour of your lovely country. We have lived with a solar electric system for over ten years and enjoy its independence and comforts. We would be happy to sit and chat about our experiences with those who are interested in this lifestyle. Likewise, anyone who is currently using a solar or alternative electric system are of interest to us. If we get to see and talk with you about your system, we will report back to Home Power central about your doings! If Intercity travels thru your area — it's likely we will be there. Discussing solar and your interesting country over a pint or cup of coffee would be for us a wonderful way to spend evenings. If you'd like that too, please write to us at the below address and we will let you know when we will be in your area. Katcha & Bill Sanderson, 20295 Panoche Rd, Paicines, CA 95043 USA

Problem Relay
HP readers who are interested in building the series-parallel controller for small EVs (HP#39) and the add-on dynamic braking feature (HP#42) will want to shop around for a better relay (K1 in both circuits) to use than the one I specified (RL 8951, from C&H Sales). Since then, the contacts of two out of five of these relays that I've installed (in three applications) have failed (fused) under high load conditions. Upon inspection, it is clear that there is a marked variation, between units, in the alignment of the contact surfaces. The misaligned closure cannot handle the current, heats up, and eventually fuses. This may blow the battery fuses or cause the wire leading to the common terminal to open. This open wire is a RESULT of the fused contacts, not the CAUSE of the contact's failure. I can recommend no current substitute. In both failures, the applications used greater than a drive of one-half horsepower or higher. If anybody knows of a relay or small contactor (12V coil) with contact ratings of 40–60A for less than $50, please let me know and share it with other HP readers too. Michael Hackleman

Pumping — Slightly Yankee
I read the water pumping article (issue #40) with interest. Here is another street on Windy's road map, slightly Yankee, slightly lower tech, and slightly cheaper, if your water is in easy reach (less than 25 feet below the surface).

Trundle off to your local conventional pump peddler/installer and scrounge a shallow well pump



"I THINK THE WIND GENERATOR BLADE IS A LITTLE OUT OF BALANCE."

with a burned motor (this should be free). Have the armature turned off the shaft, and voila... you have a pedestal pump. Put on an appropriate pulley, belt, and motor of your choice (mine was 1/3 hp 120 VDC to replace the 3/4 hp 120 vac original) and start pumping. This makes standard 30–60 psi household water. By putting an appropriate capacitor parallel to the switch to stop the arcing, you can use the store bought pressure switch. Mine has worked for 16 years with one new switch, capacitor, and set of brushes. Ted Sanford, Sanford Farms, Exeter, RI 02822

More KTU (Kitty Thermal Unit) Input
I noted with interest the discussions of KTU's (kitty thermal units) in your magazine.

The cats around here easily and consistently absorb much more thermal energy than they radiate or otherwise give off. I have also observed that they tend to increase in mass over time. I suspect some sort of energy to mass transformation. Yours in science, J McDonald, Bozeman, MT

The consensus here is that the energy to mass conversion starts with vibrating of the throat, commonly called purring. The purring expedites the absorption of emotional energy which greatly accelerates the energy

to mass conversion. Due to the energy to mass conversion we now have a large sample to study. In our experiments, at least a part of the energy, measured in kitty thermal unit (KTUs), is radiated back to the homo sapiens lap. We have been studying this phenomenon for many years and appreciate all input. Karen Perez

A New Love
You are doing good. Every issue is great.

Today I found a new love, Adobe Journal, PO Box 7725, Albuquerque, NM 87194, Phone 505-243-7801. It is a next door cousin to Home Power that I had not known before. Good information on building good homes from cheap materials. Adobe construction been with us for over 11,000 years: the Great Wall of China. Adobe Journal should be a 2nd helper to all Home Power readers. Just had to let you know of another good read. M C Durand, Lydia, LA

Ah! synchronicity! We received our first copy of Adobe Journal about a month ago. Judging from the copy we received it looks like good'un. Their mission statement says their emphasis is modern earth design and building techniques, passive solar heating & cooling, research & testing in foreign countries, to the preservation of historic earthen buildings. The quarterly magazine's format is 11 x 14", averaging 44 pages per issue, $17.50 per year. Karen Perez

Grid Intertie Billing
It's always a red letter day when my issue of HP arrives. Thank you for a great magazine. I'm writing regarding the Loweburg & Schultze article on utility intertied independent power providers, HP #42.

I currently own a 4kW windmill intertied with New York State Electric and Gas. In addition, I'm very familiar with a 3Kw hydro site connected to Niagara Mohawk. Both of these installations work on the two meter system. Net billing for me is a subject of dreams and not reality at this time.

The IPP article has a sentence that is particularly interesting to me: "It is a two meter system where you buy all your electricity at the going rate and sell all the output of your renewable sources at the rate that the utility claims it cost them to produce power, usually around 2 cents per kilowatt-hour." The words "buy all electricity" and "sell all the output" are very different from my experience. With both utility intertie systems I'm familiar with, the electricity generated by the renewable source is used by the owner first. Only when the renewable source generates more than the owner is using does the utility buy the electricity. This principle is easily seen by watching the two meters. When the wind is calm, the billing meter turns and I buy the electricity I use. As the wind speed increases, the billing meter turns slower until it stops. The credit meter will then turn if the amount of electricity generated by the windmill is greater than the amount of electricity the house is using. The electricity generated by the wind is divided between the amount that is used by our home and the amount sold to the utility. During 1993, 65% of the electricity generated by the windmill was used by our house, while 35% was sold to NYSEG. This is very different than the two meter system mentioned in the HP article where you buy all your electricity at the going rate and sell all output.

I realize that the methods and accounting systems used by utilities to handle the small IPP vary a great deal from state to state. In addition, there is no question that the two meter system is the least desirable system from the small IPP standpoint. However, I feel there is no question that the two meter system I'm working with is much better than the "buy all, sell all" system described in the article.

I would be interested to know: how many states do net billing? It sure would be great if New York could be added to the list. Keep up the great work on your magazine. Carl Berger, East Aurora, NY

You are quite up to speed on utility buy-back rates. While the "sell all/buy all" policy that Bob–O and Don describe does apply in some instances, these are almost exclusively very large IPPs that are working under power production contracts with a utility. By large, I mean in the multi-megawatt range. This is by no means any residential installation that I am aware of.

We have several hundred customers across the United States with wind systems that are connected to the utility. None of these folks are on a "buy all/sell all" contract. The two meter system that is in place in your home is the most common utility buy-back arrangement in the country. It is a simple system that allows you to use your cheap kilowatts instead of the utility's expensive kilowatts. (By the way, you did a wonderful job helping us visualize how your metering works. Why don't you consider writing an article on your system and submitting it to HP.)

When viewed in this manner, your wind system can be considered a piece of demand-side management equipment in that it reduces the load or demand that your residence places on the utility. If you were to throw out an old power-hungry refrigerator and install a high efficiency model to reduce your kilowatt hour consumption from the utility,the utility would have no right to penalize you by charging you a higher rate.

You are merely reducing your demand. The same logic can be applied to a grid-connected RE system. I have successfully used this argument with any number of utilities in negotiating buy-back rates for some of our customers. As long as you are not a net producer but only reduce your demand on the grid, the utilities can usually be persuaded to buy into the idea.

There are only a handful of states that currently offer net billing, the arrangement where the utility buys back your kilowatt hours at the same price that you pay the utility for them (i.e., the retail rate). These states include Connecticut, Iowa, Maine, Minnesota, Oklahoma, Rhode Island, Texas and Wisconsin, plus one California utility, Southern California Edison. Recently, New Hampshire was added to the list due to over a year's worth of work by Home Power readers Tim and Jill Meeh. If you are willing to persevere and work for the cause, New York could also be added to the list. I am sure that any number of us out here working for the cause of small IPPs would be willing to assist you in your effort. Mick Sagrillo

Anybody out there
In an article on an unglazed transpired collector from Popular Science Magazine, February 1994, which claims solar air heating efficiencies of up to 75%. Air is drawn through 1/32" diameter holes in a black perforated aluminum panel. Any readers out there know other details for home construction — such as hole spacing, plenum depth, etc.? Would be nice to see a homebrew article on this in Home Power.

On the list of phantom loads, my Trace 812 inverter draws 10 mA when turned off. Do other, larger inverters have larger phantom loads? Ernie Soya, KA7VIR, 44 Nota Rd, Wauconda, WA 98859

Dealer in the Philippines?
Currently, I am a merchant marine working for the US government with retirement plans for early next year from this adventure. My choice to slow down to sixty hours a work week is Luzon in the Philippines with my wife and five children. The utility problems have escalated since the exodus of the Marcos regime.

Therefore I would like to choose an independent power system consisting of PVs, wind generator, batteries, and back-up to a system of 110/230 through an inverter rated at 2600 watts continuous service with expansion option.

This I feel will satisfy my requirements for housing, citrus and vegetables on our two hectares.

To date; I have not been able to locate a dealer in the area of Zambales or San Fernando where we have easy access. Manila would even be acceptable for the shopping and assistance to set-up our system. We are just one hour from the Subic "Duty Free Zone".

I would like to hear from dealers or exporters to make this wish a reality. The question is where and how? Jack W Doyle, Cargo Engineer, USNS W.S. Diehl TAO-193, c/o FPO AP San Francisco, CA 96663

Solar Hams
Your magazine is great but a little advanced for me. Please more simple articles or "do-it-yourself" for beginners. Please run articles on running amateur radio equipment on solar — what to buy, how to hook it up for HF, packet and 2 meters. Would like a list of hams off the grid that will share their knowledge & help one another. An article on RV operation powering ham gear would be great! Kay KD5DU, 1321 Doncaster St, Irving, TX 75062

RE/Utility Survey Comments

The following are comments from the Renewable Energy Survey; HP42, page 16. For the current survey results please see page 16 of this issue.

Supplement existing utilities with solar installed at home site and large scale solar at utilities. Build no more nukes, coal or gas burning plants. Phoenix, AZ

To use a solar powered house one must have a basic sense of physics & common sense. Unfortunately many of our relatives & friends can not be relied upon to run our house or even follow directions. A certain logical way of thinking, unrelated to education level, seems to be required to take control of your own systems. This I fear, is the limitation to these systems. Winthrop, WA

Utilities are not the enemy, in fact they deliver dependable power at generally a reasonable rate. Red tape is our enemy to progress, tying the hands of the creative and productive. Mount Shasta, CA

Economies of scale mitigate for larger renewable energy plants. Equipment installed at some central point is much cheaper to maintain. We need to put much more pressure on the utilities to develop renewable energy sources. The future for individual homes is passive solar design for heating & cooling. Until it (RE) reaches the just plug it together stage, it will not have significant impact on electric demand nor be of interest to homeowners. Robbinsville, NC

Can't least cost planning concepts be applied by CPUC to utility RE programs & system design? This could forestall jumbo systems & increase zeitgeist knowledge levels on efficient appliances & lifestyles. Eugene, OR

We are delighted with the performance of our ten panel independent (off the grid) system installed over a decade ago. The weakest link had been the L-16 batteries (which were perfectly fine 90% of the time. We have upgraded to NW Energy Storage Lineage 2000. The ideal system, of course, would be an equitable grid connection. We produce more power than we can use from March to October and could use some from November to February. This challenge of sharing resources parallels many other similar challenges as our society makes the difficult transition from constitutionally protected individual rights to constitutionally enhanced interdependence with protection of natural and social resources. Rainier, WA

While we prefer the fourth alternative (scenario) most people would not (or cannot) mess with it. Any renewable energy is better than non-renewable energy. Libby, MT

Ten years ago everyone into RE wanted the utility company's to get into RE so prices would come down and public acceptance would open. Today, you and others are paranoid about ID Power & others selling RE. If you think the chotie world is manageable look at Idaho Power's last quarterly report on their PV endeavour. Swandale, ID

While I am a proponent of renewable energy, I think the utility does an excellent job. They have numerous programs to enhance the environment (free energy audits, free fluorescent bulbs, cash rebates for recyclable a/c's & frigs, cash rebates for certain energy efficient products). Silver Spring, MD

Any renewable energy initiatives at utilities are appreciated, but I don't see any here in the Northeast. And with Carrizo Plains being dismantled, what does that say for the West? Conservation is the byword, but again the incentives came from the State of New York for the power companies to (1) do education (2) offer cheap compact fluorescents & water-saving devices & wrap the hot water heater and (3) do fuel efficiency tests for furnaces & house energy evaluations. So, where's the reality in the two left-handed (grid-owned) scenarios above? Georgetown, NY

Idaho Power solar plan is highly impractical. They make an installation estimate (assume $10K) and want 5% up front ($500) with 1.2% monthly payments ($120). The user never owns the system or ever pays it off. Idaho Power maintains (winter in mountains and emergencies???) system on a five year contract, renewable at their discretion. This doesn't hold a candle to a user owned (and financed) system. Why waste their time? New Plymouth, ID

There is no room for monopolies in a Democratic society. All utilities should be "not for profit organizations", with elected representatives, elected by the people they serve. IPPs should, by law, receive the same price for their power as the local utilities. Orlando, FL

Free market will see utilities in the RE business. They should receive no special governmental support! They can compete like everyone else. Communities would benefit from utility RE projects local to the community, such as the recently completed project in Winchendon, MA where roof panels on many houses provided a "pool" of RE for the group of houses. Most house owners would not take the initiative to operate RE. Therefore, for the ecological good of all, the utilities should be encouraged to do community RE development. Acworth, NH

It seems obvious to me that with so many homes already connected to the power grid & the fact that batteries are often the most dangerous & environmentally hazardous part of RE systems that the most good we can do is to push utilities to purchase excess power from those of us willing to provide it. This way I could (or anyone could) for instance, recharge an electric vehicle at night with energy essentially produced by me in the day with solar panels. I realize that's not what is actually happening, but if one produces more energy than they consume, the net effect to the planet should be about the same. I eventually envision the whole country connected via local utilities who no longer produce any power, just switch it from areas of the country producing more than they need to areas of the country who need it for one reason or another. Stowe, VT

Any solar use is good. Boulder, CO

You are off base with your appraisal of Edison & solar sales/lease. The majority of the public is not like us. They buy from Edison but they have no idea they could buy from you (or could not afford to buy up-front). This is a debt, plastic society & they'll go for Edisons sales because it's accepted (ie. loans) on payments & because they trust big companies. Big Bear City, CA

Any form of utility conversion to renewable energy should be welcomed by the public as a step in the right direction. Zapata, TX

We have two 25 Kw wind turbines, 6 Kw of PVs and 15 Kw CHP. We sell 50 MwHs per year to the utility raising $9000. (Grid intertie system receiving 15¢ per KwH for their RE produced power. The retail rate is 10¢ per KwH.) Great Britain

I believe that we must always preserve the option for

owners to do it themselves. It is the only way to keep things honest. Craftbury Common, VT

If we are going to make a significant impact on the planet, RE needs to get into grid-land. Like the scenario of PV on every flat surface or south facing roof in the country, but I see technological, political, economic hurdles. 1) Utility intertie inverters need to be perfected & standardized 2) Political support for this idea must be rallied to apply pressure to the mega$ utility industry (ex: CARB EV Initiative). 3) We need to help the utilities figure out how they can make money at this. (Ex: demand-side management programs that work.) Oakland, CA

Other utility involved options: Better—Utility installs & maintains system at my site, we purchase system over time. Best—They just finance & install system in rural subdivisions like mine, I maintain it. Instead of million dollar power line extensions, welfare electricity. Fairbanks, AK

At one extreme — utility company owns & charges for everything, there is no independence, everyone suffers from blackouts/brownouts. At the other extreme — completely independent RE, no grid — reliability is again a problem. Some sort of grid is needed so people/businesses can share power. I tend to favor utility-controlled grid, because they can employ professional engineers, high-tech equipment, etc. Which "Joe do-it-yourself" won't have — high efficiency means lower cost. The best is somewhere in the middle. We need more local RE sources, but also to use cleaner (non-polluting) utility-size sources. Utilla, MI

CVPS (Central Vermont Public Service) charges a monthly line maintenance fee ($9/Mo). The town of Milton encourages alternative energy development for residential use. The town does not assess any tax for installed alternative energy devices. I am hoping to install PVs and a small windmill to provide my energy needs. Have written CVPS about utility intertie and have little response. CVPS just went through a load of bad press about not supporting energy conservation in the state. I think the Rural Electrification Act should be modified so utilities pay and must ask permission to use people's property for power transmission. If they profit from use they should pay for access and not have dominion. Milton, VT

An interconnected system eliminates batteries and levels power production. The power company avoids purchasing new equipment if the IPP owns the AE production system. The only downside is paying a monthly bill to be connected. Balance this against battery cost and maintenance. Having lived off grid for 12 years I've learned that conservation is definitely the key. Hot Springs, AR

All the above (scenarios) have a place in the future depending upon people's situations. People should own their own batteryless renewable energy system on their house. The weak point in renewable energy systems is the storage. It is expensive, short-lived, toxic and dangerous. A renewable energy future with a lead-acid battery bank or NiCd battery bank in every household is not a good one. This is a good function for the utility — to distribute electricity from where it is available to where it is needed. Most households would be batteryless and run their meters both ways. They would all have solar panels and so would the utilities to fill in the gap. Mendocino, CA

Off-grid power systems will always be a miniscule percentage of users in the US. If we want renewables to make an environmental impact, the utilities will have to utilize them, either centrally, or likely near the fringe of its grid. The utilities are experimenting with off-grid systems, but I don't think it will go very far, it just won't pay for them. The environmental problem for off-grid systems is batteries (YUK) & here in the NW, engine generators, which pollute far more than any central power plant for the power produced. Olympia, WA

95% of the American public will never want to have a PV system installed at their house unless the payback period was 2–3 years or less and there were no batteries and/or maintenance. Most people are not interested in making their own power! Though they complain about their electric bill now, they are not wiling to spend $20 on a compact fluorescent bulb, with a payback of just a few years. The idea of PVs on everyone's home will work only if we can do something like PV singles at a maximum cost of 100% more than conventional shingles and there are no batteries.PVs will have to be installed at large "farms". I feel, though, that it is critical that people who wish to have their own system may do so at a reasonable cost. I see these "farms" as 50% to 5% the size of existing plants. Taylorsville, CA

The good thing about interconnecting with the utility is that they act like a huge battery and my neighbors buy my excess power (from the utility). The bad thing is that they can be a pain in the butt. It took 1 1/2 years of negotiation to sign a contract including filing with PUC, opening a docket there, hearings, waiting for decisions, arguing about decisions based on ignorance. We are now almost one year into trying to resist new protective relay requirements which they are trying to lay on us after we have our "authorization to generate". Canterbury, NH

Utility-scale RE is the only realistic solution for densely populated areas, mostly because people are too lazy/indifferent to do it on their own. The profit motive will prevent it from being any cheaper than non-renewable sources. (Our RE highlights — surviving two hurricanes with power while the rest of Kauai was squirming for months and in 1991 a flood carried away our box of Carrizo panels we had just received but hadn't installed. We found them 1/2 mile away buried under debris — installed them & they still work perfectly!) Anahola, HI

In the far North spring, summer & fall provide a rich solar & wind energy flow. Winter time power production currently requires the use of fossil fuels & utility scale production is more efficient than individual gen/set production & battery storage. The cost of powerline distribution offsets this, however. Healy, AK

Our (utility) power is interrupted more than five minutes at least once every two weeks, and out more than one hour at least once a month. Van Nuys, CA

Selling power to utility OK, but lousy price paid by them — 10% of what we pay them. Greenwood, NH

We want no part of any utility connection in any way shape or form. Sanger, TX

Renewable energy is the right path for many reasons, but especially because it teaches us what power really is and how to conserve it. We all need to know this! Browerville, MN

I do see where it could be a viable business to have equipment owned and maintained in a lease/service-fee payment way, but to award an "authorized " monopoly with the smoke screen of "professionalism" to keep the owner from doing it by themself is Not acceptable. Responsibility is the best system. Paicines, CA

There are over 2000 barges of coal that pass through the lock at Dubuque every year. The maintenance of the Mississippi (River) is controlled & paid for by the Army Corps of Engineers (Tax $). It's another hidden cost savings for the utilities. When the utilities loose all their tax breaks & we get to play on a level field, we will have our fair share of the energy market. Dubuque, IA

I see grid-intertie coming. The politics now favors the big utilities. They have the money and a unified policy making structure. They will try to use this advantage to write the rules to favor them. Until I see laws which create a level playing field (net payment, single meter systems) I will stay independent. Bandon, OR

The only thing I miss about gird power is not having a freezer & with enough money I'll get one some day to run of my system—would never go back to grid power. Whitehall, MT

We need lower cost solar to hydrogen. Richmond, CA

Since I paid my last power bill in 1972 I have trouble relating to anything but self-reliance for electrical energy consumption. I know that not everyone wants to live at the energy consumption level that I do (.726 kiloWatt hours per day), but I'm very comfortable and can't image living any other way. I think that every household should evaluate power needs by a "begin–from–zero" plan. Instead of saying "Where can I conserve?" It should be..."What do I need?" I suspect that most of us do not want to rely on the good will of the utility companies to meet our needs. Mosier, OR

Up front capitol costs & long term financing is necessary for people to be able to jump into RE. Low interest loans with 10 year pay backs secured by the potential KWH the system can produce plus the value of the equipment. Randolph, VT

We have never been on the grid at this location. Counting everything we have installed, we still have not spent the amount of dollars they (public utilities) wanted to just bring power to our property. We continually add to our system and are very proud/happy with what we have! We feel we live very "modern" and comfortably. We are not dead yet, and in saying that would like to say we would never rejoin "The Grid". If forced to do so, I'm sure it would be kicking and screaming. Roy, WA

Centralized control stifles innovation, encourages waste. Nahcotta, WA

If we can't get a lot more people interested within 5 years the Feds will have the individual regulated out of buying solar equipment. Center Ridge, AR

Decentralized power generation is the future — period. One day I WILL be off-the-grid! Austin, TX

We need to own our own equipment and live within our own energy production "means". Not living within our means in any area gives others power over us whether it be power companies, banks, or governments. Grangeville, ID

It seems to us that the utilities ought to be servants of the people. If they are allowed to exist as monopolies, no profit should be allowed. Spencer, OK

Power lines are ugly, dangerous in some places (neighborhoods), lose tremendous amounts of power through transmission losses and radiate strong fields. These are my main objections to interfacing with utilities. There are, of course, many other valid

objections to the existence of utilities — period! Bend, OR

The home buying consumer needs major re-education in energy efficiency, construction techniques and choice of power sources. Cedar City, UT

Centralization is inefficient & keeps control in corporate hands. Unstable. Utility equipment on home owners property invites corporate "strangers" onto a homestead. Ultimately, ownership should be by homeowner. Townsend, VT

Centralization of power (electric or politic) is inefficient, dangerous and inhibits our taking responsibility for our own well-being. The system designed from the roots (grass) suits the users needs, not the needs of the big organization. Anything that encourages people to take responsibility for their our basic needs in this society is a plug. Quincy, CA

Hopefully we will be completely off the grid in another year, but not in this location in inner-city Portland, OR. We our fed-up with the BS that our utilities put out regarding "jobs", "growth", and the "real cost" of hydro and nuclear power. Our consumption is high now. We have an electric stove, water heater and inefficient refrigeration. We use compact fluorescent lights everywhere. The PV panels run the computer, a couple of lights and eventually the stereo. Portland, OR

Most people & businesses are in cities. Most of these will not or would not be capable of generating electricity. Most people & businesses in this country are tied to the utility & capable of generating electricity. The conclusion is inescapable; private people & businesses are capable of generating most of the electrical power needed in the "Lower 48". (All your own & excess!) If the utilities would help instead of hinder means to this end the overall lasting benefits are not possible to be seen or known at this time — only dreamed of. It's time to take another "Giant step for mankind!" Dillard, OR

We originally installed solar as a "back-up" to the grid dependence. We have learned to live with "sun power" and only wish we had enough panels & batteries to be completely independent — we would love to be in a position to sell power to Puget Power! Yelm, WA

PNM (Public Service of New Mexico) presents so many hassles that we're getting more batteries rather than attempting an intertie. Albuquerque, MN

After 18 years of producing our own power with zero blackouts, why would we want to affiliate with grid or distribution companys who support nuclear reactors. Lyons Falls, NY

In 12 years on solar we have never has a power outage, we have a 30 acre ranch a mile and a half from the nearest paved road or electric pole and want to keep it that way. Perris, CA

Our independence may come easier when we all become totally responsible for our actions. Columbia Falls, MT

The government should not subsidize renewable energy or any grid energy. To me renewable energy is not an environmental issue, it's an American sovereign issue, by not depending on foreign governments for our energy to run our nation. Salt Lake City, UT

We are completely off-grid and self-sufficient with no powerlines run to our property. Our system is very reliable and we have had no equipment malfunctions since installation. During recent storms (lightning, snow/ice, etc.) our neighbors have been without power for periods as long as one to two weeks—we had all the power we needed. Cleveland, SC

Hydro power is seasonal. In a years time I buy approximately $300.00 of electricity from PP&L and they pay me approximately $10,000. I cannot think of any other use for this excess power. They are a good customer, pay well, and my renewable power is off-setting some of the nuclear and coal power on-grid. Pillow, PA

We were forced by the bank to hook-up to the grid before they'd loan us money to build our dome home. High Springs, FL

Get a Job!

POSITION OPEN:

The Board of Director's of the Midwest Renewable Energy Association (MREA), producers of the annual Midwest Renewable Energy Fair, is accepting resumes for the position of executive director. This is a full time position requiring organizational, administrative, communication, and computer skills. Also required is a working knowledge of the technologies, economics, and politics of renewable energy issues. Must be willing to relocate to the central Wisconsin area. For a complete job description, call 715-824-5166. Send resumes to: MREA, PO Box 249, Amherst, WI 54406.

JOB WANTED

Kelly Larson, PO Box 9752, Reno, Nevada 89507, (702) 329-4150

Objective: Full or part-time position in alternative energy/renewable resources.

Education: Master of Science in Electrical Engineering, University of Nevada, Reno, projected December 1994.

Bachelor of Science in Electrical Engineering, University of Nevada, Reno, May 1992. 3.8 GPA on 4.0 scale.

Professional Skills: Background in commercial broadcasting, automation, research and maintenance. Mechanical skills gained through training and employment as a military helicopter pilot. IBM and MacIntosh literate with programming experience. Good communication skills.

Employment History: DOE-EPSCoR Scholarship Recipient, University of Nevada, Reno, 1993-94. Investigation of photovoltaics, impedance spectroscopy, and lasers.

Engineering Intern, National Renewable Energy Laboratory, Golden, Colorado, 1993. Investigation of thin-film photovoltaics, renewable energy production and alternative energy resources.

Graduate Fellow, University of Nevada, Reno, 1993.

Station Engineer, NASA Crustal Dynamics Laser Satellite Ranging Station, Quincy, California, 1992. Station engineering, maintenance and operation.

Research Assistant, University of Nevada, Reno, 1991-92. Investigation with computer modeling into the effects of high-frequency and high-current applied to underground pipelines.

Helicopter Pilot and Life Support Maintenance Officer, Co. D/113 Avn., Nevada Army National Guard, 1984-1991. Solely responsible for aircraft operations and crew, maintenance of all life support equipment and survival training.

Aviation Life Support technician, Army Aviation Support Facility, 1985- 88. Developed and implemented maintenance program, coordinated flights, attended military schools.

Transmitter and Automation Specialist, KKBC Radio Station, 1982-83. Programmed computer automation and transmitter equipment for interruption-free operation.

I have been looking forward to finding a position in renewable energy prior to the start of my Electrical Engineering studies in 1988. For many years I have been intensely interested in photovoltaics, and have made it my hobby to read and investigate the history of alternate energy production, current technologies, and recent breakthroughs. I have been a Home Power reader and attended SEER for many years. I always enjoy gaining knowledge about the products and ideas that make living with alternative energy possible. I also look forward to the possibility of living "off the grid".

I will have a Master's Degree in Electrical Engineering in December of this year. During my studies I investigated photovoltaics from electrical engineering, physics and material science prospectives. I also was awarded an internship at the National Renewable Energy Laboratory (formally SERI) in Golden, Colorado to further my experience in alternative energy. As my resume indicates, I am computer literate in both IBM and MacIntosh. I also gained extensive experience working in teams and in supervisory positions while in the National Guard. I am willing to relocate, and am looking for an area with a clean environment and small town feel where I can settle down. I will consider a full or part-time position, and would prefer a somewhat flexible working schedule.

JOB WANTED

Alfred Cohen, 860 Rushmore Ave, Mamaroneck, NY 10543, 914-381-2367.

Jordan Energy Institute graduate seeking employment in the alternative energy or environmental restoration field. Experience includes: Solar domestic hot water and solar heated pool installation and maintenance, stream macroinvertebrate analysis and clean-up. Willing to train in wind technology. References and resume available. Interested in relocating to the Pacific Northwest or Southwest (AZ or NM) but willing to entertain other options. Seeking a cooperative living situation: rent sharing, co-housing, land trust, or egalitarian intentional community (urban, sub-urban or rural but must have access to urban cultural scene). Currently on long job-hunting, home hunting road journey. Would like to decide by this fall or early winter.

JOB WANTED

I am a 26 year old Mechanical Engineer here in New Zealand where I have been working for the previous four years as a product designer for a whiteware manufacturing company. I would dearly like to make Renewable Energy Engineering my job (currently a hobby). Can you suggest companies I could contact in the United States that may be able to help me gain experience in Renewable Energy Engineering while working as a Mechanical Engineer? If you can help in any way it would be greatly appreciated.

Guy Robinson, Te Rangi ita, RD2, Dunedin, New Zealand

I can be faxed through my father's work. The fax number for this is:

C/O Brian Robinson, University of Otago Chemistry Department, Fax 0064-3-4797906.

I am submitting this resumer early in an effort to discover any interest. I am going to be in Okinawa Japan until November of 1995 and would like to get job interviews lined up for the future. I do understand it is early to make any permanent decisions. I will be getting out of the Marine Corps November of 1995. I would like to get some response on any type of interest. Thank you.

JOB WANTED

Matthew Alden Edwards — US address 2511 S Cedar, Sioux City IA 51106

Condensed Resume: Calibrated and repaired, by front panel milking and schematic reading, a wide variety of digital and analog equipment ranging from multimeters, oscillators, signal generators, counters and oscilloscopes to spectrum analyzers, microwave counters. Using standards traceable to the National Institute of Science and Technology. With my knowledge of computer operating have put a library of over 1,200 manuals into a database. Taught others how to use a computer system to calibrate and trouble shoot equipment with capabilities. Knowledgeable in the area of Enable, Lotus, Windows and many other software applications. As an engineering student considering possible fields of study/work I would like to know more. Actually, I would like to do more and see for myself what alternative power is all about. If you know of any individuals, corporations, or institutions that would be interested in having an intern, research assistant, or summer employee, please pass my name on to them, or their name on to me.

Japhet Koteen, Swarthmore College, 500 College Ave, Swarthmore, PA 19081, email jkoteen1@cc.swarthmore.edu or

japhet@SCCS.swarthmore.edu

JOB WANTED

Daniel Mark Healy, 8161 Popular Way #304, Englewood, CO 80112, (303) 843-9713. As an enthusiastic and innovative engineer, my goal is to improve the environment by broadening the use of renewable energy. I have attended hands-on workshops, read many renewable energy related books and magazines and have been a member of ASES since early 1992.

Training: Graduated from the University of Florida in 1990 with a BS in Aerospace Engineering. Attended the 1992 American Solar Energy Society Conference. Participated in the PV System Design Workshop at the Florida Solar Energy Center; February 1992. Completed the Siemens Solar PV Technology and System Design course in February 1994. Interned with Martin Marietta Electronics & Missile Group where I worked with a team to prepare the ADATS vehicle for field testing and learned several IBM CAD systems.

Experience: Lockheed Space Operations Co. as part of the OMS/RCS group; promoted to Senior Associate Systems Engineer. The group was responsible for processing the space shuttle's on-orbit attitude control system; Shift Lead Engineer which included supervising the daily work on the shuttle's left OMS/RCS pod.

Excellent communications skills combined with a background of team leadership, problem identification/resolution and the ability to function well in demanding environments. Capacity to learn and apply new technology.

Got a Job? Want a Job? Listings in this column are free. Contact Hofme Power, PO Box 520, Ashland, OR 97520 • 916-475-3179 or Internet Email: karen.perez@homepower.org

Q&A

Alaskan Radio
I have an important question for Bob-O, the ham operator. How is that Trace sine wave inverter for generation radio interference? This is our big problem around here, where we are at the outer limits of reception for AM. Our favorite NPR station being 150 miles away behind some major mountain ranges. Turn on the inverter (Trace 1512) or fire up this Powerbook on anything except the internal battery and radio reception goes over the hill. Has Bob-O, Richard or anyone else looked at the waveform on the battery side of these sinewave inverters? That's where the trouble comes from, with the RFI fed back through controller and panels, which act as an antenna.

I've been working with the management of the public radio station KCHU on the installation of an FM translator for McCarthy, AK and have designed a solar power system for it. This has some interesting and unusual features which will be the subject of an article for HP one of these days. The AM receiver (Sony 2010) is coupled to 2000 feet of antenna to get a decent signal. This makes it exquisitely sensitive to interference. We had to boot out a Cruising Amp-Hour meter because it generated too much interference (how does Bob-O deal with this?) A thermoelectric converter installed for mid-winter power supplement uses a DC-DC converter to get from 4.7 Volts to battery charging level. Way too much RFI. We haven't solved this one yet. Always something coming up, but we do plan to have the translator on the air sometime in July. Originally it was to be last January, but the RFI problems are nothing compared to the FCCs paperwork morass. Would you believe that we have to get Canadian clearance to go on the air, even though the border is 40 miles away from our flea-power 10 watt translator, on the other side of the highest mountains in North America? Best wishes to all. Ed LaChapelle, PO Box MXY, McCarthy, AK 99588

Hiya Ed, One of the many things Kathleen and I missed when we moved here from the California Salmon River country was our addiction to a certain AM talk radio station at night. Over there it was easy to just turn the old Trace 2012 inverter off at night as all our lighting was 12V incandescent. That's hydro country and our main battery worry was overcharging! Moving to the land of PVs, 24 hr fax machines, and 120 vac fluorescent lighting put the kibosh on AM until the Trace SW4024 came on the scene. We now listen to AM at night on the old Realistic DX-150A off the built in ac supply! Our antenna is about 400 feet of old telephone twin-lead that the phone company left up when they brought in a new six pair line. The waveform on the ac side of the 4024 looks like a Mayan temple on the scope with 34 to 52 steps per cycle depending on the load. You'd think it'd be noisy, but nope, quiet as a church on Monday. We haven't looked at the DC input side of the machine yet, but we will. I get no interference from my Cruising Amp/Hour +, even though it's a very early model (Serial #103) with the latest ROM update. Have you called Rick Proctor at Cruising? He's always been responsive and helpful to my ranting and raving when things go wrong. Maybe your older Amp-Hour meter has a problem that can be solved. Never met a choke or ferrite bead I didn't like. Best of Luck. Bob-O Schultze

High Amperage DC Generator?
I enjoy Home Power. You are to be complimented on an entertaining and informative magazine. One product that generally seems to be missing from the alternative energy catalogs which I have seen is a high amperage DC generator designed specifically for battery charging.

The general rule of thumb for ac generators is that you can get about 500 watts per engine horsepower — if. a 4000 watt generator requires an 8 horsepower engine. If this were available as 12 volt DC, a 1000 amp-hour battery could be charged in about three hours using only a couple of dollars worth of gas. But is seems that the only high-amperage method that the only high-amperage method available requires battery chargers, which are expensive and inefficient (330 amps of 12 Volt battery charging capacity would cost around $1500 just for the chargers and they would probably not deliver more than 80% of the input energy to the battery).

Alternative Energy Engineering offers a DC charging kit which couples an alternator to a small engine. But they say that a 5 hp engine is required to deliver 50 amps of 12 Volt DC. This is only 600 watts — compared to the 2500 watts you would expect from the same engine turning an ac generator.

I understand that a 4000 watt alternator designed to deliver 12 Volt DC would have to be larger then the equivalent 120 volt ac generator. But I do not understand why it should take a larger engine. I thought a watt was a watt. Do you have any information on the efficiency of automotive alternators? I suppose that the producers of a 100 amp alternator designed to be coupled to a 250 hp V8 may not care whether it is 45% efficient or 80% efficient — as long as it produces its rated amperage.

Could two or three automotive alternators be used to charge a battery bank at the same time without hurting the alternators? If so, about how much engine horsepower should I allot per 100 amps of capacity? I would appreciate your comments and suggestions.Lin Waterman, Caldwell, ID

Hi, Lin. Automotive alternators are less efficient than 120 vac alternators. Auto alternators are designed to run at 4,000 to 7,000 rpm, while 120 vac alternators run at either 3,600 rpm or 1,800 rpm. This means that the car alternator must be "geared up" from the engine driving it (around 2.5 is best). There is substantial power loss in this gearing-up process. Car alternators are designed to produce power at low voltages. Ohmic losses (resistance) also reduces efficiency. You can use several alternators at once to charge your battery. I recommend 5hp of engine for every 100 Amps of current in 12 Volt systems. Having an oversized engine also means that the engine will live longer. My experience with the 5 hp engines driving the 4kW 120 vac alternators is bad. Five hundred hours and the engine is toast! See HP#42 for an article on 12 VDC engine/alternators. Richard Perez

Nickel Cadmium Battery Health
I am looking for information on maintenance, testing and operating my remote homestead NiCd battery system.

My batteries are twenty used ALCAD brand NiCd batteries. When I got these batteries their voltage ranged from about .067 volts to 1.29 volts. So far, I've hooked up ten of these batteries (those over 1.2 volts) in series to provide 12 volts to my inverter which in turn supplies 110 ac to mainly lights in my house. About half of the remaining ten batteries range from .067 volts to .421 volts. The rest are at 1.2 volts or above.

I've heard I should not mix the low voltage batteries with those having 1.2 volts. Can these batteries with .067 V to .421 V be mixed in with the 1.2 V batteries? Can the .067 or .421 V batteries be brought up to the same capacity as the 1.2 V ones without compromising the capacity of the 1.2 V batteries? Is this what is meant by equalizing?

My primary goal at present is to operate a 12V Sun Frost Model F-10 chest freezer off these NiCd batteries, using solar panels and diesel lightplant to keep the batteries charged. Besides the twenty reconditioned NiCd batteries the other components of my system are: Heart HF 12–2000 SU inverter, two Solarex MSX 60s, Lestermatic Model 09710 50 amp charger, 6Kw single cylinder China Diesel, Tripplite LC–1800 line stabilizer/conditioner, Tripplite BC–600 LAN battery back-up system (last two for my computer).

Is the Lestermatic charger good, bad, or OK for charging the NiCd batteries? Can you suggest a charge controller between the solar cells and the batteries? A device for testing the capacity of the NiCd's? The electrolyte presently shows between 1.150 and 1.175 on the hydrometer. The Heart inverter will apparently not operate the Tripplite BC–600 LAN which I want to use to protect the computer system. Would a Trace inverter operate the BC–600 LAN? I'd appreciate any information you can give. Thanks. Mike Sallee, PO Box 1195, Ward Cove, AK 99928

Hi, Mike. The ALCAD cells are an excellent brand. It is impossible to tell a good alkaline cell from a bad one by measuring its voltage. Put the cells into service and give them an equalizing overcharge. Charge the cells to an average of 1.65 VDC per cell. That's 16.5 Volts DC for a ten series cell battery. Keep charging the battery at a C/20 amperage rate for at least five to ten hours. All the cells will boil furiously during this equalization process. If your cells are in fact "reconditioned", then they will take five cycles of this regime to reach their full capacity. The electrolyte density you mentioned is low. This is a symptom of electrolyte carbonation. Good cells have an electrolyte specific gravity of between 1.900 and 1.240. The Lester is fine for alkaline cells. I recommend the Heliotrope CC series PV control for alkaline battery systems, although you now have too few PV modules to require any regulation. I suspect that the LAN will not digest any form of modified sine wave power. Use a sine wave inverter to power the LAN. — Richard Perez

Sizing
After four and a half years pushing my reel mower around the 1/3 acre yard, I've finally upgraded to a Black and Decker CM600 cordless lawnmower. (I've also been adding garden plots and some trees.)

For years now I've wanted to get a solar charging station up and running. Mainly, it would serve to charge the mower and several other small power tools... a drill, a weedeater, a small circular saw, a small vacuum cleaner, etc.

My first problem is to select panels of adequate size. The mower's battery is 12 Volts. Its plug-in charger is rated at 120v, 1.7 A, and 40 W (I guess that's the input). The charging voltage on the cube is 15.5 Volts. Wouldn't I need some sort of regulator between the photovoltaic panels and the battery?

The second problem is that the tools are rated at different voltages. Could I build a regulator that varies the voltage according to the battery requirements of each tool? (PowerPro vacuum cleaner — 7.2V, Weedeater — 6V, Circular Saw 1 — 12V, Circular Saw 2 — 9.6V, drill — 6V)

Perhaps one of your homebrew articles has already published what I need, but I don't recognize it. Could the regulator in issue #38, pg. 72, do the trick (I'd love to put together a kit instead of breadboarding)? Please help!

Hopefully, all of this will serve as a prelude to a future off-the-grid home. This project could help me get my feet wet. Thanks for your instructive and inspiring magazine.

Ken Fackler, 141 Brooks Dr, Martin, TN 38237

Hello, Ken. Build a minisystem around a single 50 Watt PV module, a small 12 VDC marine style, deep cycle, lead-acid battery and a 100 to 200 watt 12 VDC to 120 vac inverter. Use the factory supplied power supplies to recharge each appliance. This minisystem approach is more useful, more powerful and cheaper than recharging each appliance directly from individual PVs. The homebrew circuit you mentioned is designed to couple a PV module to an electric motor. It is not suited for your use. — Richard Perez

Inverter Sizing
We are in the process of purchasing an inverter and don't know if we should get a Trace 800 watt with standby or the Trace 2512 with standby, Our needs now are small electricity wise but probably will grow as time goes on — Sun Frost refrigerator — more wattage added etc. It's a quandary whether to buy small & trade up or go with the larger one right away. If it's not to much trouble could you advise. We have the usual TV, VCR also but really don't use much power at this time. Paul Kent, Joseph, OR

Well, Paul, I'd say go for the bigger inverter if you are planning on keeping it for at least two years. The increased capacity will allow you to not only expand your lifestyle to include solar-powered power tools and a microwave oven, but it will give you a much more effective battery charger. If you are planning on trading up to a sine wave inverter in the future, then the larger inverter will have much better resale value. — Richard Perez

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LOOKING FOR NEW NEIGHBORS. We are searching for an off-grid "neighborhood" along the Oregon coast and Coastal Range of Oregon, preferably from the Florence area north. We would be interested in areas on the Olympia Peninsula and the southwest Washington coast as well. Also looking for co-op homeschooling potential. Write to Mark & Shannon, 5227 NE 18th, Portland, OR 97211

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M.R.E.A. 1994 Fall Workshop Series

The 1994 Energy Fair is over but the information and educational services provided by the MREA's Educational Institute continues. In-depth workshops will offer hands-on experience to those interested in the nuts and bolts of renewables and energy efficiency. For more info, call or write the

Midwest Renewable Energy Association,

PO Box 249, Amherst, WI 54406 • 715-824-5166

How to Build an Affordable Natural House Using Timber Frame, straw/clay, earth plaster, & earth floor — October 28 –31 — Robert Laporte, Natural House building Center, Fairfield, IA. (Workshop located in Amherst, WI) Robert is the owner of Natural House Building Company and writer of Moose Prints, A Holistic Home Building Guide. He has conducted workshops detailing natural home building methods throughout the country. This workshop brings together four natural house construction methods: timber framing with info on the plan design, layout, cutting, assembly, and rising. Straw/clay building with info on materials, tools, clay types, ecological harvesting, clay slip recipes, and straw clay roofs. Earth plastering, including info on tools and materials, plaster recipes, and applications. Earth coupled construction discussing the base, screen, sub-floor, earth floor, stone floor, and mortared floor. A class project will give everyone hands-on experience. Cost $400. Registration deadline is October 1, with a $50 non-refundable registration fee.

Residential Solar Energy: Doug Steege — October 22 — Altech Energy. Madison, WI. (Workshop located in Madison, WI) Doug, a co-owner of Altech, has long been an educator, writer and renewable energy advocate. Doug brings his historical perspective to this workshop. This workshop covers solar heating and home design. Included in the course: The historical perspective, active solar systems, passive solar systems, collection and storage systems, conservation and insulation, air to air heat exchangers, moisture barriers, and discussion on the future of solar energy. Cost $100. Registration deadline is October 10, with a $25 non-refundable registration fee.

Introduction To Renewables —November 11–13 — Mick Wurl-Koth, Solar Spectrum. Tomahawk, WI. (Workshop located at Treehaven Learning Center, Tomahawk, WI) MIckey has been a long time advocate and educator on solar and renewable energy. Mickey and his wife Julie are the co-owners of Solar Spectrum, a solar energy business in Northern Wisconsin. The workshop covers a wide spectrum of renewables — photovoltaics, wind, passive solar, solar hot water, etc., and includes a field trip to the passive solar designed Wurl-Koth home, complete with a working wind generator on a tilt-up 100 ft. tower, photovoltaic system, solar hot water system, and cookies from the home's solar ovens. The Treehaven Learning Center is a wonderful facility complete with a cafeteria, recreation room, and miles of hiking trails in Wisconsin's north woods. Cost $250. Registration deadline is November 1, with a $50 non-refundable registration fee.

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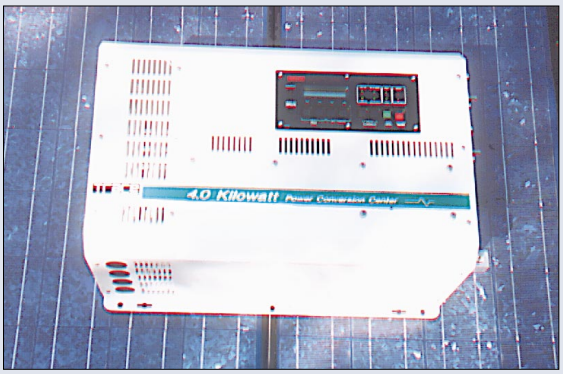

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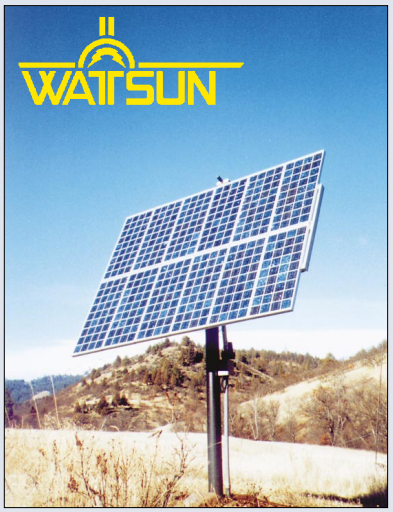

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